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*University of Minnesota*
*Agricultural Experiment Station*



# *An Analysis of the Cost of Tile Drainage Installation on the Farm*

*By H. B. Roe*
*Division of Agricultural Engineering*


UNIVERSITY FARM, ST. PAUL

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# AN ANALYSIS OF THE COST OF TILE DRAINAGE INSTALLATION ON THE FARM

By H. B. Roe

## INTRODUCTION

As drainage is a large and important problem in agriculture in Minnesota, and as very little definite knowledge regarding its cost on the individual farm has been developed elsewhere, extensive investigations of methods of installation and costs of tile drainage have been carried out by the Division of Agricultural Engineering, of the Experiment Station. The result is a mass of data on costs which are herein analyzed and presented in a form readily available for use.

## SCOPE OF THE INVESTIGATIONS

### Classification of Projects According to Character of Surface

The investigations on which this bulletin is based were carried on from 1908 to 1921, inclusive. The areas involved fall naturally into three principal classes: rolling land, flat land, and peat land. The purpose of the investigations was to separate the costs into their fundamental elements and to determine suitable and balanced cost units for each element for each class of land. The aim has been to keep these units as independent as possible of local and temporary economic influences and conditions.

### Drainage Projects Involved

The actual farm drainage projects serving as a basis for this discussion are listed in Table I, page 39, which gives the number, location, time of installation, and general character of the tract involved in each. The projects have been numbered in the order of the dates of installation, and this order of numbering will be adhered to throughout the bulletin. Figures 1 to 18 show the general layout of the tile systems on the projects.

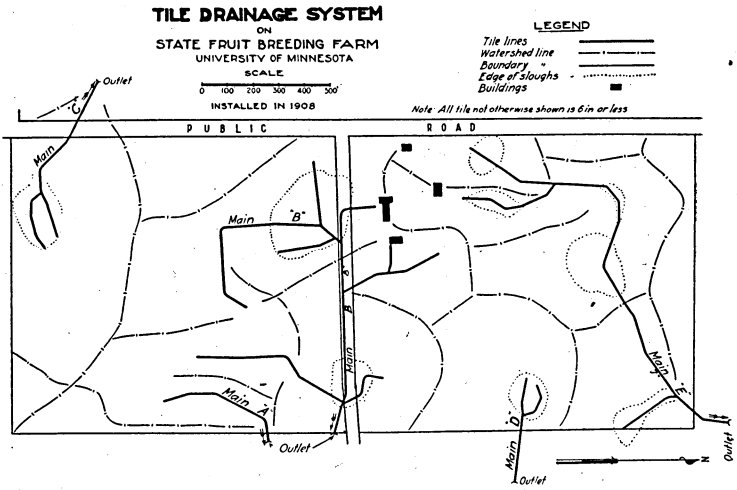



Fig. 1. Project 1. Rolling Land

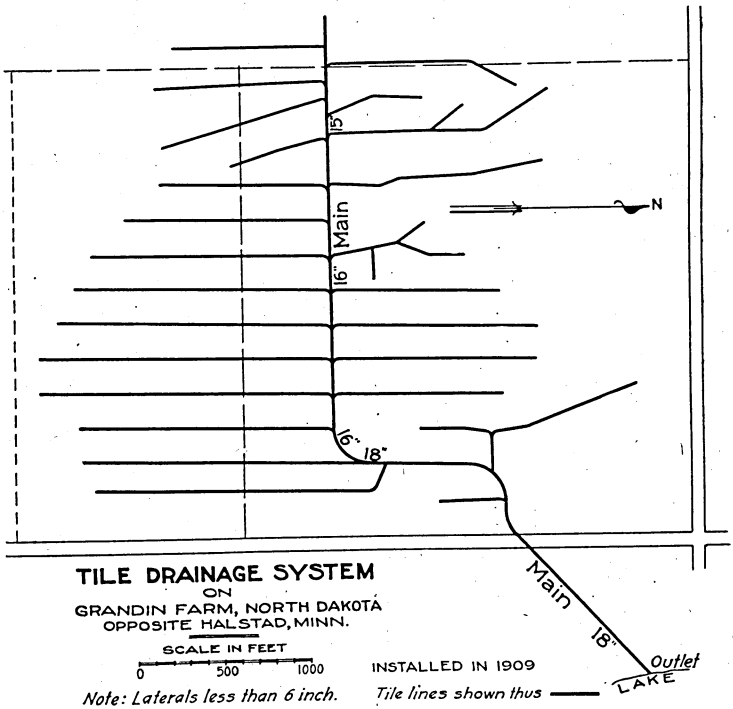



Fig. 2. Project 2. Flat Land

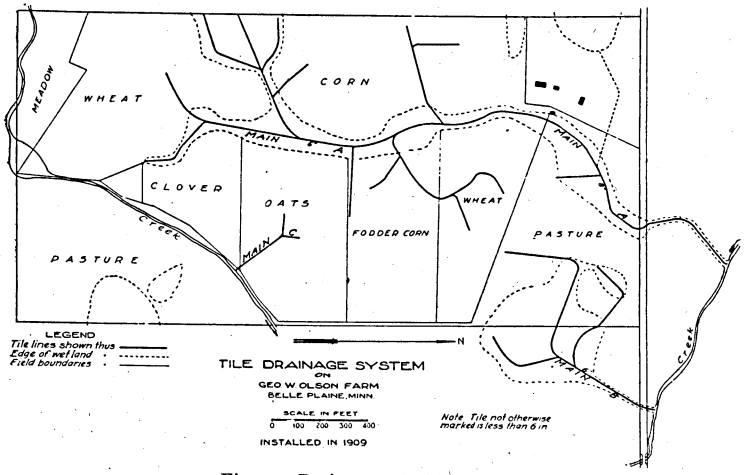



Fig. 3. Project 3. Rolling Land

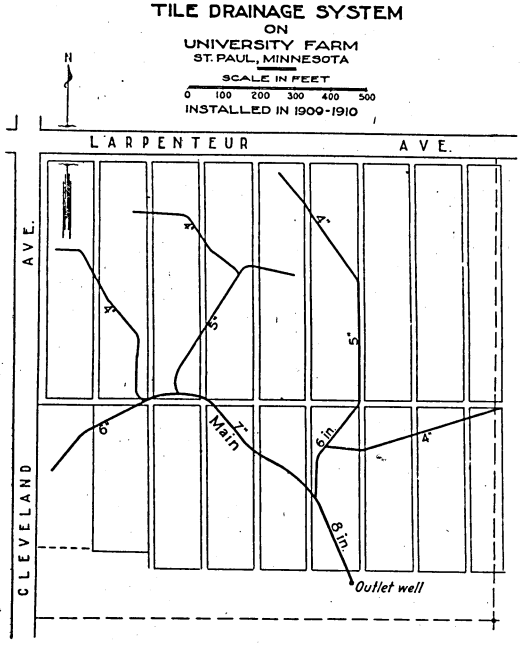



Fig. 4. Project 4. Flat Land

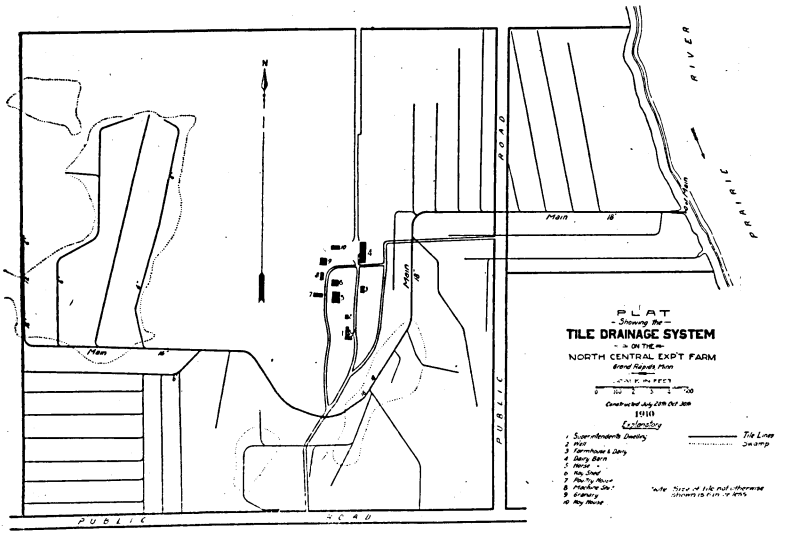



Fig. 5. Project 5. Flat Land

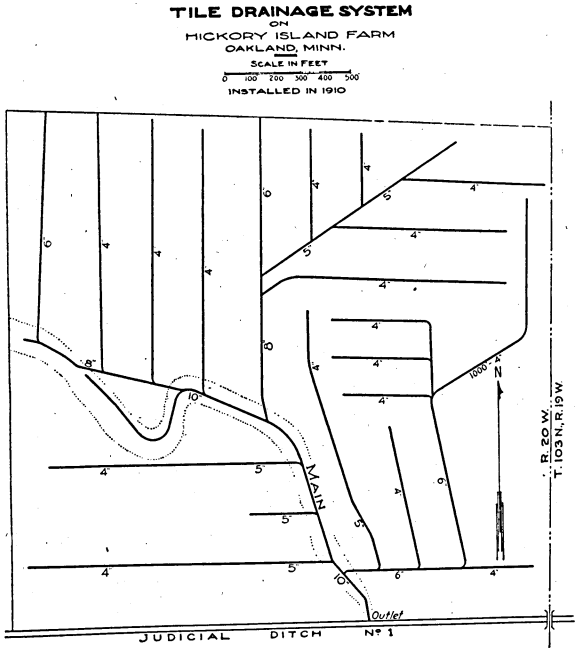



Fig. 6. Project 6. Flat Land

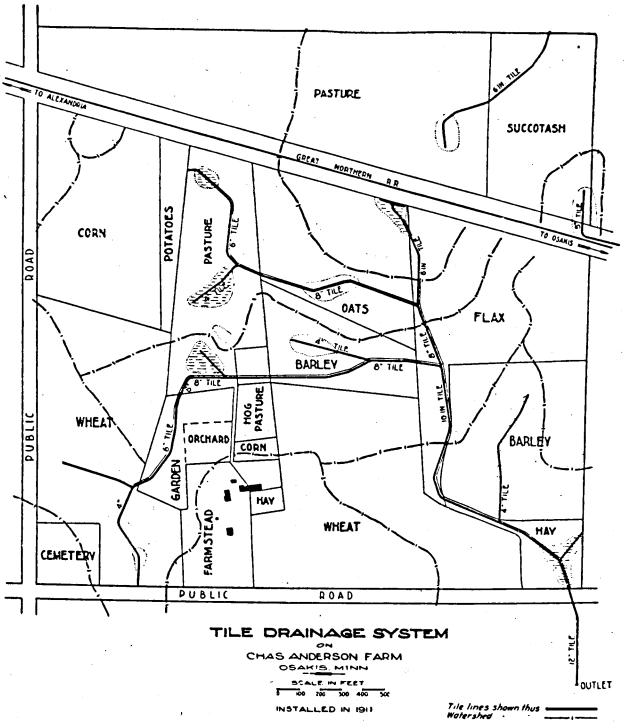



Fig. 7. Project 7. Rolling Land

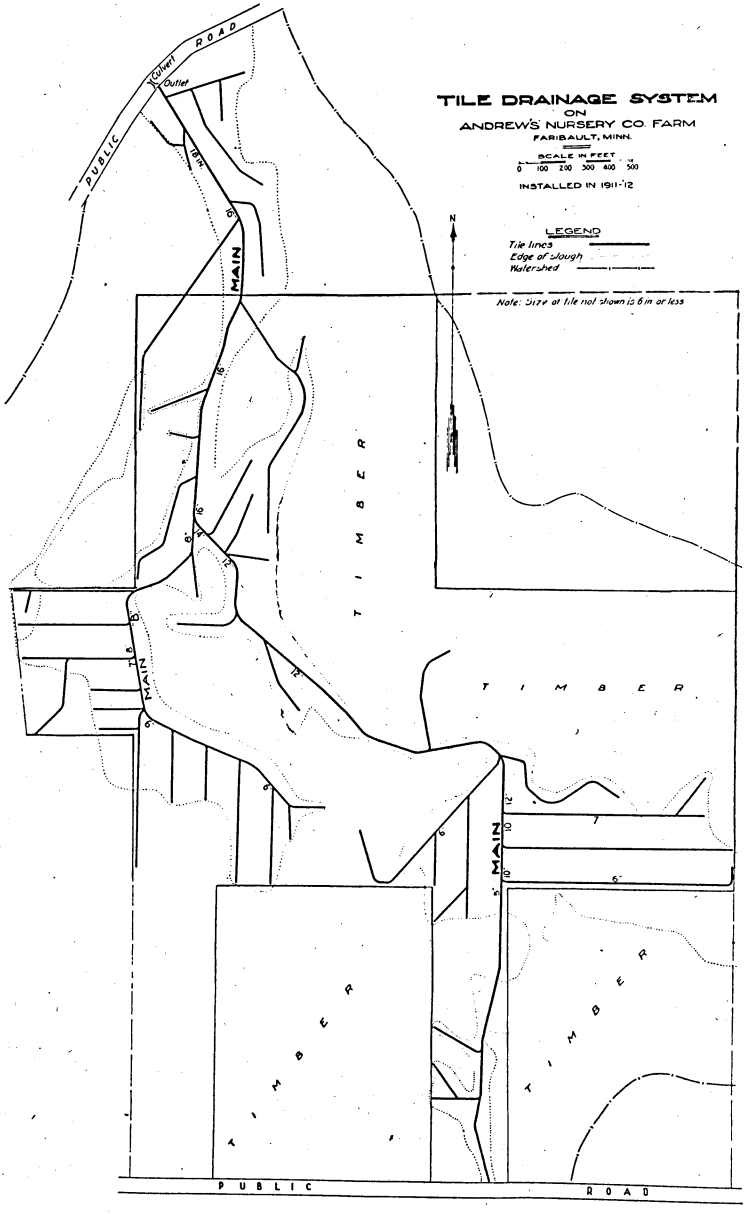



Fig. 8. Project 8. Rolling Land

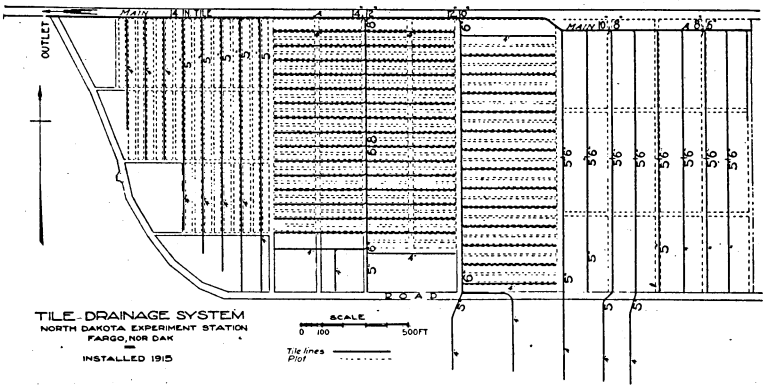



Fig. 9. Project 9. Flat Land

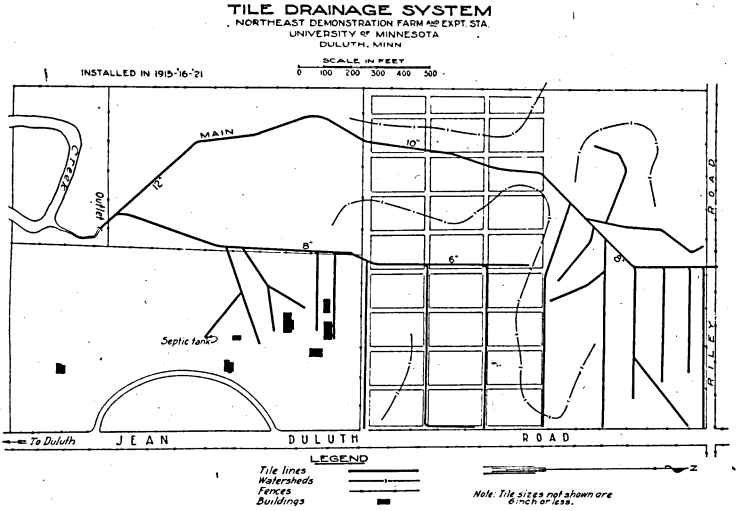



Fig. 10. Project 10. Rolling Land

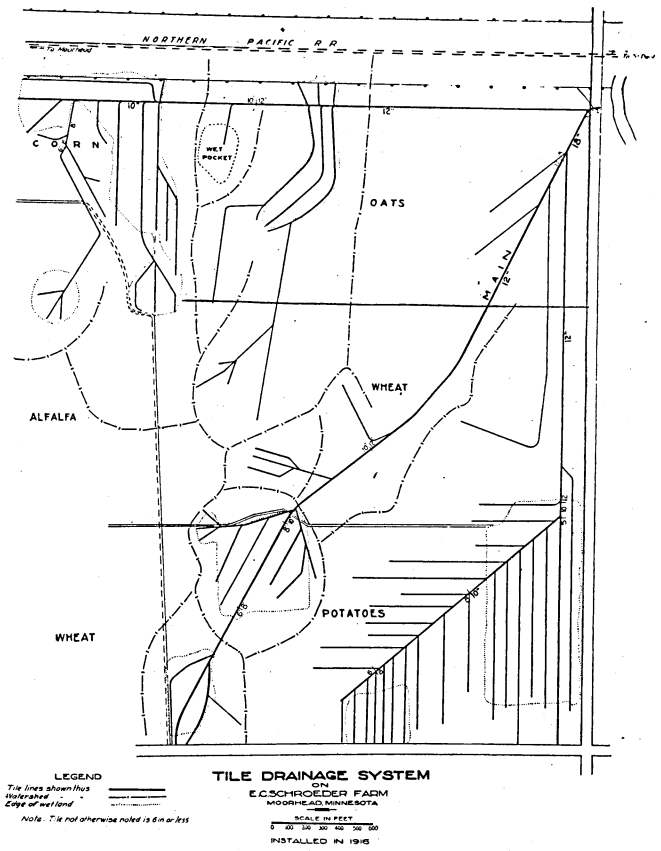



Fig. 11. Project 11. Flat Land

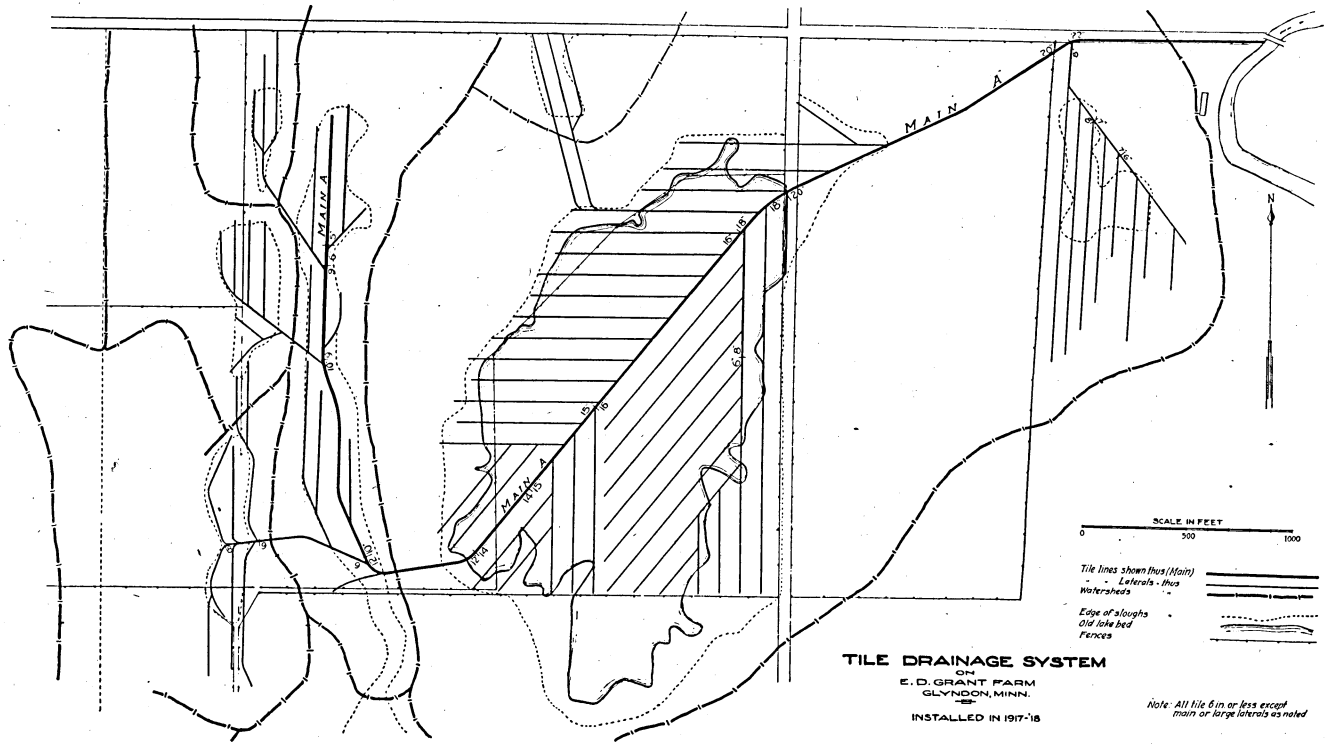



Fig. 12. Project 12. Flat Land

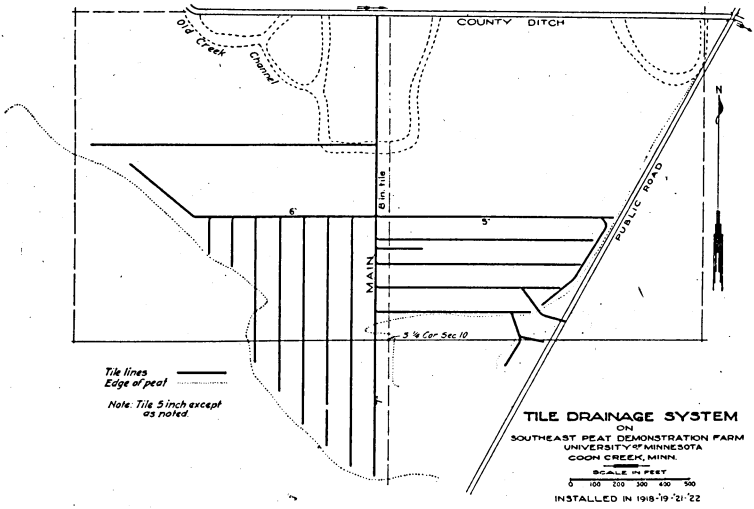



Fig. 13. Project 13. Peat Land

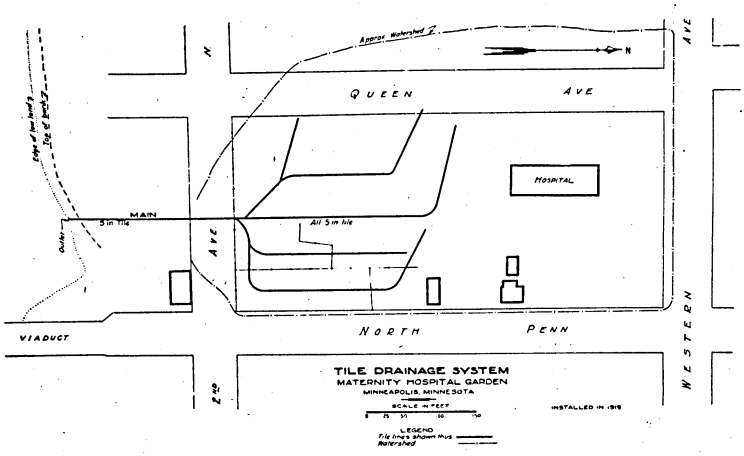



Fig. 14. Project 14. Rolling Land

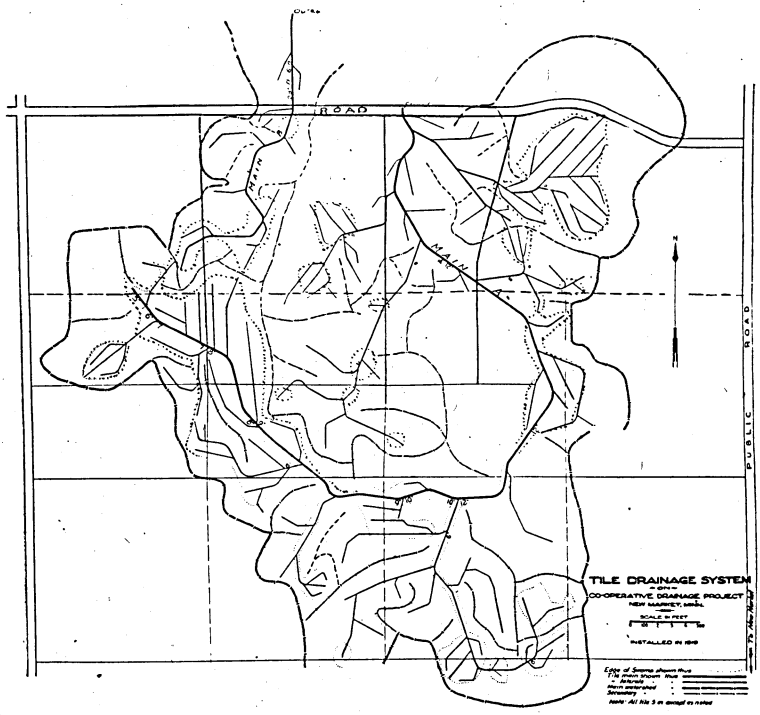



Fig. 15. Project 15. Rolling Land

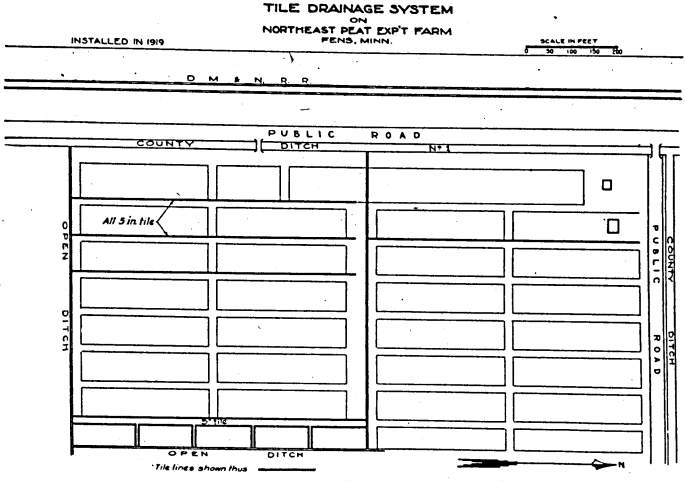



Fig. 16. Project 16. Peat Land

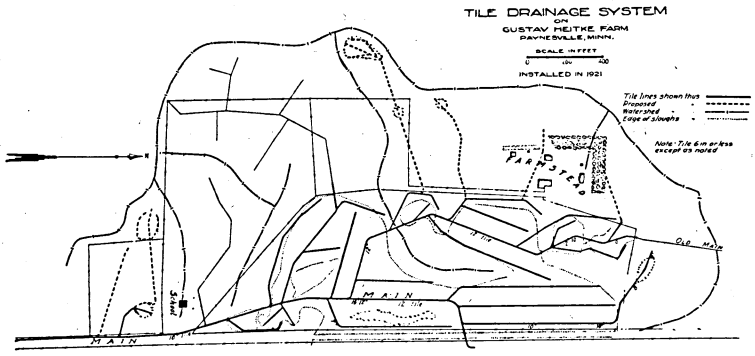



Fig. 17. Project 17. Rolling Land

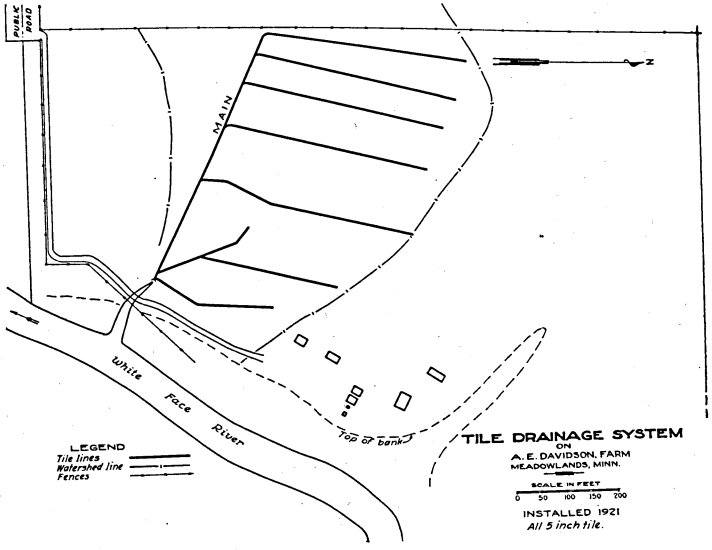



Fig. 18. Project 18. Flat Land

## ELEMENTS OF COST, WITH DEFINITIONS

The cost of any ordinary farm tile drainage system is made up of the following distinct elements:

Engineering and supervision
Tile
Freight on tile
Haul and distribution (hauling the tile from the railroad station and distributing it over the fields along the proposed tile lines)
Trenching, laying, and blinding the tile
Refilling trenches
Outlet protection
Miscellaneous minor items

**Engineering and supervision** includes all work of an engineering character—field survey and design, and engineering supervision and inspection of the construction work, as well as all attendant clerical and drafting-room work.

**Tile** includes all closed pipe used in the system, both drain tile and sewer pipe, but does not include outlet culverts.

**Freight on tile** includes the actual railroad freight charges from factory or other point of purchase to destination.

**Haul and distribution** includes all costs of unloading the tile from the cars; loading it on wagons, sleighs, or trucks; hauling it from the railroad station to the fields; and unloading and distributing it along the drain lines.

**Trenching, laying, and blinding** includes all work of digging the trenches and finishing them to the grades established by the engineers; laying the tile in the finished trench; and blinding the tile (covering them to a depth of from six inches to a foot to hold them in place and prevent disturbance until the trenches are to be entirely filled). It is customary to consider *trenching, laying, and blinding* as one operation because they are intimately associated in point of time and it is well nigh impossible to separate them. Prices for this work usually include these three taken as a unit.

**Refilling trenches** includes all work of filling the trenches after the blinding has been done. This class of work is far simpler than the preceding and does not require skilled labor.

**Outlet protection** includes the labor and materials involved in providing proper protection for the tile outlet against crushing and undermining and against the entrance of birds and animals.

**Miscellaneous** includes all such items as a limited amount of open ditching at the outlet or in connection with other items; the

installation of catch basins and surface inlets; temporary ditching preceding the regular installation in order to remove surface water and make regular construction work possible; the placing of boards in the bottom of the trenches in soft spots; and minor tools and equipment purchased especially for the project in hand and virtually used up during the job.

## CLASSIFICATION ACCORDING TO DRAINAGE CHARACTER OF SURFACE

It is often convenient to consider drainage cost on a per-acre basis and in one of three ways, namely, per acre of water-shed on the farm involved, per drained acre, and per totally reclaimed acre. Therefore, in this analysis, the various units have been worked out on each basis. Table II, page 41, shows the area of each of these classes for each project.

## ACTUAL MONEY COSTS OF PROJECTS

As the time covered by these investigations includes periods of widely varying economic conditions, the actual cost of each or any project is not a definite basis for final conclusions, but will be convenient for making comparisons and for working out useful percentages discussed later. The actual total costs of each project and of all projects in each land class, on the acre basis, are shown in Table III, page 43.

## PERCENTAGES OF TOTAL COST REPRESENTED BY EACH ELEMENT

It is convenient to know the percentages of the total cost represented by each element, as by their use a fairly close estimate of the cost of any project can be obtained where a tolerably reliable value of any one element is known. While the projects included in these investigations may not give conclusive percentages, still, as they cover a wide range of local conditions, character of surface and soil, the percentages obtained may be fairly representative of farm drainage work in the state, especially when the affected areas are classified according to character of surface. Such percentages, together with corresponding actual costs of each element, are shown in Table IV, page 44.

## BASIC UNITS

For general use, independent of time and economic conditions, it is necessary to establish general cost units not expressed in terms of dollars and cents but which are readily reducible to such terms if prevailing values of labor and of certain types of materials are known. The normal basis of all costs involving labor is the hour unit. This

will apply to engineering and supervision costs as well as to the common, labor items, in this discussion. Table V, page 46, shows the total hours of man, horse, and machine labor involved in each element of each project as well as the total time for each element on all projects. These totals are used later in determining average fundamental units of work and average amounts of work done per hour in the different elements.

### The Time Factor

The data on time spent on each project are believed to be fairly reliable altho part of the time on some projects is estimated (see Table V). In this respect the projects fall into three classes:

1. Those in which the time record is exact.
2. Those in which part of the time record is exact and the rest is estimated between approximate dates.
3. Those in which the entire time has been estimated, as carefully as possible, between approximate dates.

If the exact time was not known, the time consumed on the different parts of the work was carefully estimated. The estimates were made after careful scrutiny of all available records and after consultation, wherever possible, with others in responsible charge of the work.

It is often desirable to know the cost or the amount of materials or labor required per acre, per thousand feet, per ton, or per minimum carload of tile (30,000 lbs.), hence tables are included showing the money costs, hours of labor, and materials required, distributed on this basis.

## COST OF EACH ELEMENT

### Engineering and Supervision

Engineering and supervision on drainage work is usually paid for by the day at established professional rates and includes both compensation for service and necessary traveling, subsistence, and special expenses incurred in connection with the work. On most of the projects discussed the engineering and supervision was done by members of the station drainage staff and the compensation in these cases was therefore determined by their annual salaries at the time the work was done. Table VI, page 48, gives the actual cost of this element for each project, the cost per hour, and the total cost, distributed on the acre basis, as well as per thousand linear feet, per ton, and per carload of tile; and also the hours consumed by this element, distributed on the same basis.

### Tile

Tile is usually sold per 1000 linear feet, and, in large orders, in carload lots; while contractors and tile manufacturers base their market price on the cost of handling a ton of materials. Table XI, page 55,

gives the total cost of tile on each project, distributed on the usual acre basis; and in connection with Tables VIII, IX, and X, per 1000 linear feet, per ton, and per carload.

Table VII, page 51, shows the actual linear feet of tile of the different sizes used on each project in each class of land. However, it is also convenient to consider the tile, from the general standpoint of size, under two classifications: (1) that required for mains and submains, which includes all tile more than 6 inches in diameter; (2) that required for minor field laterals, and including all tile 6 inches in diameter and less. Table VIII, page 52, shows the linear feet of tile on each project, distributed under the two main classes and also on the established acre basis. On flat and peat lands the general parallel spacing of minor laterals approximates 100 feet, whereas on rolling lands the systems are natural systems and the position and extent of minor laterals are governed almost wholly by the general topography.

Table IX, page 53, gives the tons of tile used on each project according to size, and distributed on the established acre basis; while Table X, page 54, gives the same information expressed in minimum carloads of 30,000 pounds. The data of Tables VIII and IX can be used in making preliminary estimates of tile required for a given class of land.

## Freight on Tile

Railroad tariffs on tile, as on other commodities, are very unstable through a period of years. Therefore dollars-and-cents statements of freight are of little value in a discussion of this character except as they are used in connection with the general trend of costs *according to the length of railroad hauls*. For purposes of approximate estimating, therefore, the average length of railroad haul is of service. Approximate details of this haul for each project are given in Table XII, page 56. The actual miles were taken from printed railroad schedules, where the routing was known. In the few cases in which it was not known and in which more than one routing was possible, the most probable and usually the shortest routing was taken. The total carloads in this table are taken from Table IX. The total money cost of freight, as well as its distribution for each project, is shown in Table XIII, page 57. The most interesting and most useful unit is the cost per carload mile of railroad haul. The cost per hundredweight in carload lots, which is the customary commercial unit in which freight is figured, as well as the trend of such rates, may easily be obtained in any case from the cost per ton of tile.

## Haul and Distribution

Unloading tile from the cars, hauling it from the railroad station, and distributing it along the drain lines is usually done by the farmer,

using man labor for loading and unloading and either horse or gasoline power for hauling. Conditions vary widely in different localities and at different times of the year. It has, therefore, been pretty well established by custom that in estimating haul and distribution we should follow the lead of the railroads in establishing a fundamental unit of cost which would fit our case; that is, this unit should be the cost of hauling one ton one mile, or what is commonly known as the cost per ton mile. Table XII, page 56, shows, along with the carloads and carload miles, the average miles of team or truck haul on each project, and the total tons hauled, together with the product of these two sets of items which gives the total ton miles under each project. Table XIV, page 58, shows the actual money cost and the labor cost in man hours, of haul and distribution of the tile.

### Trenching, Laying, and Blinding

Table XV, page 60, gives the actual money cost and the cost in man hours of labor for trenching, laying, and blinding. The figures are of value in approximate preliminary estimating and for approximate comparison with other elements, but should not be used for close estimating or as a basis for bids because this element is one of the largest two elements in the cost of tile drainage and the amount of labor involved in digging trenches varies widely with the size of the tile, the depth of the trench, and the character of the soil and subsoil, and this variation is not uniform. In this connection it is therefore necessary to consider the average cut on any given project for the different sizes of tile, and also the character of the digging as determined by the kind of soil or its local physical condition; while the surface character of the land has no appreciable influence in fixing the unit rate of cost in this element. The importance and intricacy of this element are such as to warrant separate treatment.

## BALANCED COST SCHEDULE FOR TILE TRENCHING[1]

### General Considerations

#### Character of Digging

The character of digging falls naturally into three classes; easy, average, and hard. A schedule is developed covering each of these classes. Of the 18 projects only 2 fall within the first class, both of these being in peat; 14 projects fall within the second class, almost wholly in mineral soil; and 2 fall within the third class, also in mineral soil.

**Easy digging.**—Under easy digging are included soils and soil conditions which presented no serious obstacles to spading and casting—light soils of rather loose texture, free from roots, stumps, loose

[1] This schedule is built on a man-hour labor unit.

gravel, stones, or boulders—in which the spade settled readily under light pressure and where there was just enough moisture to give firmness to the soil, to make the trench walls self-sustaining and the spade slice coherent enough to cast easily. Under this class might be listed such soils as peat free from tough fibers, roots, and stumps; light, porous sandy loams; sandy clays; and the finer damp sands. For projects under this class, see Table XVI, page 61.

**Average digging.**—Under average digging are included soils or soil conditions requiring considerable but not excessive pressure to settle the spade, and considerable effort to cast; soils with a slightly frozen surface—possibly requiring the occasional use of the pick—a few cobblestones, boulders, or stumps; or material which, while easily spaded, is hard to cast because of its weight but is generally sufficiently coherent to make casting easy and caving of trench walls infrequent. Such conditions occur most frequently in ordinary prairie soils except after protracted drouth and when the ground is frozen. For projects under this class, see Table XVII, page 62.

**Hard digging.**—Under hard digging are included all conditions not included in the other classes—conditions of moisture or soil texture that cause a fairly constant tendency for the trench walls to cave; looseness, heaviness, or wetness of material that makes it difficult to cast; a degree of hardness, either natural or on account of drouth, that makes spading difficult or impossible and necessitates the frequent use of the pick or explosives; the presence of heavy sand and gravel, frequent cobblestones, boulders, or stumps. Under this class may be listed ground frozen to a considerable depth, hard pan, cemented gravel, coarse loose sand, heavy gravel, very stony soils, and soils so hard from lack of moisture as to be difficult or impossible to spade in ordinary fashion. For projects under this class, see Table XVIII, page 64.

### Limiting Sizes of Tile and Depths of Trench

The tile used ranged from 4-inch to 22-inch and depths of cut varied from 3 feet to slightly under 12 feet. Data on sizes of tile and depths of trench were complete on all projects.

Altho 4-, 5-, and 6-inch tile are seldom used in trenches more than 6 feet deep and more seldom in those more than 8 feet deep, and altho trenches of less than 4 feet for tile from 18-inch up are undesirable, for the sake of completeness and uniformity of appearance, Tables XX, XXI, XXII, XXIII and the corresponding curves shown in Figures 20, 21, 22, and 23 are constructed to cover trenches from 3 feet to 12 feet deep for tile from 4 inches to 24 inches in diameter.

### Time Factor

Of the two projects in easy digging, one falls under class 1 and one under class 2 as to reliability of time data, the latter constituting about 81 per cent of the total work in easy digging.

Of the two projects in hard digging, one falls under class 1 and the other under class 2 as to reliability of time data, the latter constituting only about 38½ per cent of the total hard digging.

Of the remaining 14 projects, all average digging, eight fall under class 1, four under class 2, and two under class 3, as to reliability of time data, the latter two classes combined constituting about 63½ per cent of the total average digging.

### Reasonable Maximum Error in Estimated Time and Resultant Work Units

The approximations under class 2 probably do not involve a maximum error in total time on any project to exceed 10 per cent, and those under class 3 not to exceed 15 per cent. Hence the error in work units per hour under each class of digging will not exceed: easy digging, 8 per cent; average digging, 8 per cent; hard digging, 4 per cent.

It is therefore also probable that the error in time per 100 feet of trench obtained from the tables and diagrams in this report will not greatly exceed: easy digging, 9 per cent; average digging, 9 per cent; hard digging. 4 per cent.

### Character of Tables XVI, XVII, and XVII

Tables XVI, XVII, and XVIII, pages 61, 62, and 64, present physical facts of general interest on the different projects involved, as well as some data derived in the process of computing the final schedules, and explained later.

## METHOD OF PROCEDURE

### Fixing Upon a Work Unit

In order to secure a schedule based on the fundamental scientific idea of work as expressed in foot-pounds, it was first necessary to determine a work unit readily adaptable to the class of work involved. As density of material on different jobs varies widely, it is evident that the foot-pound is not a suitable work unit. But if it is assumed that the material excavated *on any given job,* taken as a whole, would be more or less uniform in texture and density, a volumetric unit proportional to the foot-pound would be a suitable *comparative* work unit. Hence, the work unit here adopted is *the lifting of one cubic foot of earth through a vertical distance of one foot,* as this is readily determined from the data on hand. The number of such units performed in digging a trench of any given depth for any given size of tile and the number of such units constituting a normal hour of work were computed

as shown in the discussion of Tables XIX and XX, pages 64 and 65. By reference to Figure 19b, page 28, it will be seen that the determination of the foregoing values involves the computation of the areas of cross-section of trench and spoil bank, and of the vertical distance between the centers of gravity of these cross-sections.

It has been stated that most hand tilers think of a trench in depths of the number of spades rather than the number of feet, everything up to 3 feet being called two-spade work, from 3 to 4½ feet, three-spade work, and so on, and that a cost based on cubage does not take this feature into consideration. This fact is immaterial, because the cost data for depths of 3 feet, 4½ feet, 6 feet, etc., representing depths of 2, 3, and 4 spadings, etc., may be taken from the tables or curves instead of consecutive feet. The values thus obtained are still correct and usable because based on the established unit of work, that is, the lifting of one cubic foot of earth through a vertical distance of one foot.

## GENERAL ASSUMPTIONS

(See Fig. 19a, Fig. 19b, and Table XIX)

1. **Uniform type of trench cross-section.**—For small sizes of tile many skillful tilers prefer to save work by digging to a form of cross-section approximating that shown in Figure 19a, leaving a shoulder at the top of the last spading in order to provide a working shelf to stand on, and width enough to work in, for which the minimum is about 16 inches. However, this shoulder practically disappears with tile 10 inches and upward in diameter and it was found that the use of such a shoulder caused an awkward non-uniformity in the law of the trenching curve for small sizes of tile as compared with that for the larger sizes. On this account, in the final development of the work unit, the shoulder was omitted and the sides of the trench were reckoned as a continuous surface upward from the springing line of the concave that forms the bottom of the trench, the type of section used throughout being illustrated in Figure 19b.

2. **Batter or side slope of trench walls.**—Experience has shown that when a narrow trench is being dug, even when the sides of the trench are to be as nearly vertical as possible, the natural tendency is to give a slight slope or batter to the sides where the soil is firm enough to stand without sheathing. Furthermore, giving a slight batter to the face of an excavation seems to increase its self-sustaining power in undisturbed soils that are tolerably firm. Some study of this problem was made at this station several years ago, and the records of the work indicate that tendency and practice give an average batter of about 0.75 inch to the foot of depth, or practically 0.06 of a foot to a foot of depth. Hence a uniform batter of this ratio was used on each wall,

making a uniform total flare of 0.12 foot per foot of depth, reckoning upward from the springing line in each case.

3. **Location of springing line.**—For simplicity in computation, the springing line was assumed at the extremities of the horizontal diameter of the basal concave. The theoretical error introduced by this assumption involves nothing of greater significance than the third place of decimals in the area of trench cross-section, expressed in square feet.

4. **Outside diameters of standard tile.**—All standard tile was assumed to have an outside diameter equal in tenths of a foot to the number of inches representing its internal diameter; that is, the outside diameter of a 4-inch tile is considered as 0.4 of a foot, that of an 8-inch tile as 0.8 of a foot, that of a 12-inch tile as 1.2 feet and so on. This is nearly exact and is systematic.

5. **Overwidth of base of trench.**—The additional width of trench allowed at the springing line to admit handling the tile readily and to allow for irregularities in individual tile, was taken uniformly at 15 per cent of the outer diameter.

6. **Spoil bank; top width, and slopes.**—The spoil bank was considered to be on level ground and to have an average top width of one foot, and side slopes of 1½ feet horizontal run to 1 foot of vertical rise.

7. **Average lift.**—The average lift was considered as the vertical distance between the center of gravity of the trench cross-section and that of the spoil bank cross-section. See "Method of computation of Tables XIX and XX.")

8. **Lowering and placing the tile, a work element.**—Lowering the tile into the trench was considered work of the same general type as excavating the earth, and the vertical height through which the tile was moved was in all cases considered equal to the depth of the trench.

9. **Adjustment of machine and team hours to man hours.**—In computing the total hours of trenching labor on each project wherever the Bennett horse traction ditcher was used (Item 9, average digging, Table XVII), it was found to be the equivalent of about 4.4 average men. Wherever the Buckeye traction ditcher was used (Items 11 and 12, average digging, Table XVII), careful comparisons of time and amount of work with the other projects in the same class of digging indicated that it was the equivalent of about 8.4 average men on those jobs. These two equivalents were used in reducing all the machine trenching labor to a man-hour basis. Where team labor entered into the trenching work, a team without driver was in all cases balanced against a man tiler.

It has been the observation of some that trenching machines of the heavy traction-wheel type are more efficient in deep trenching than in shallow trenching. Strictly speaking, therefore, it is probably incorrect to assume that trenching-machine efficiency is constant regardless of depth of trench. However, for the following reasons, it is not probable that this assumption will seriously affect the practical value of the schedule herein developed.

Only a small part of the machine work included in the data used involved trenches more than 6 feet deep and most of the remainder involved trenches under 4 feet, none of which is to be considered as deep trenching.

It has been the general observation of the writer (not, however, backed by specific data) that hand labor, also, is more efficient on trenches from 4 to 6 feet in depth and for sizes of tile from 12-inch upward than on shallower work with smaller tile.

On the general run of farm drainage projects only a comparatively small part of the trenching exceeds 6 feet in depth.

In the construction of any farm drainage project, therefore, it is probable that the variation of labor efficiency relative to depth of trench is fairly consistent throughout, regardless of the method by which the work is done, and that this variation is not sufficient seriously to affect the usefulness of the schedule herein developed.

## METHOD OF COMPUTATION OF TABLES XIX AND XX

**Ratio of tile material to excavated material.**—The ratio, "s" between the density of the material in tile walls and that of average soil excavated from tile trenches, was obtained by computing the average of a series of air-dry weights of standard drain tile, both concrete and clay or shale, and comparing these with the generally accepted average weight of clay or heavy clay loam soils. These ratios are about as follows:

| | |
|---|---|
| For clay or shale, about..... | 1.0 |
| For concrete, about ..... | 1.25 |

It was assumed that by far the greater part of the tile 8 inches and less in diameter would be clay or shale tile, while above 8 inches it might stand an equal chance of being either clay, shale, or concrete, so for 8-inch tile or less "s" was taken as 1.0 and for all other sizes as 1.125 or 1-1⅛.

**Areas and distances.**—The area of cross-section of the standard tile sizes, the area of the trench cross-section and of the spoil bank cross-section, as well as the location, in vertical axes, of their centers of gravity and the vertical lift between them were all computed by standard geometrical and algebraic methods.

Table XIX, page 64, is presented as illustrative of ten such tables that it was necessary to compute, one for each size of tile as follows: for 4-, 5-, and 6-inch; 8-inch; 10-inch; 12-inch; 16-inch; 18-inch; 20-inch; 22-inch; and 24-inch. The meaning of the various values shown in Table XIX and the methods by which they were computed are shown in the following lists of symbols and formulas.

It was inadvisable to compute such tables for 7-, 9-, and 15-inch tile, the curves in Figures 20, 21, 22, and 23 being so close together as to be confusing.

**Explanation of symbols shown on Figures 19a and 19b and used in Table XIX**

(All dimensions are in linear feet and all areas in square feet.)

**On figures 19a and 19b and Table XIX**

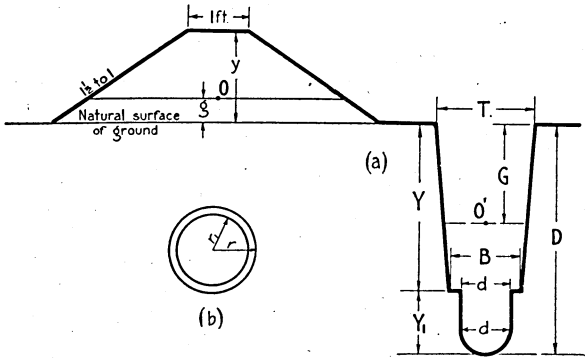
D = total depth of trench
T = width of trench at top
d = diameter of semi-circular concave forming base of trench
Y = vertical depth of trench from top
to base of battered slopes, Figure 19a;
to springing line, Figure 19b
$Y_1$ = vertical depth of trench from
base of battered slopes to bottom of trench, Figure 19a;
springing line to bottom of trench (d/2, or radius of semicircular concave), Figure 19b
O′ marks the center of gravity of trench cross-section
G = vertical distance, surface of ground to center of gravity of trench cross-section
1 ft. = assumed constant width of top of spoil bank
y = vertical height of spoil bank
O marks the center of gravity of spoil bank cross-section
g = vertical distance from base of spoil bank to center of gravity of spoil bank cross-section

**On Figure 19a only**

B = width of trench at base of battered side slopes

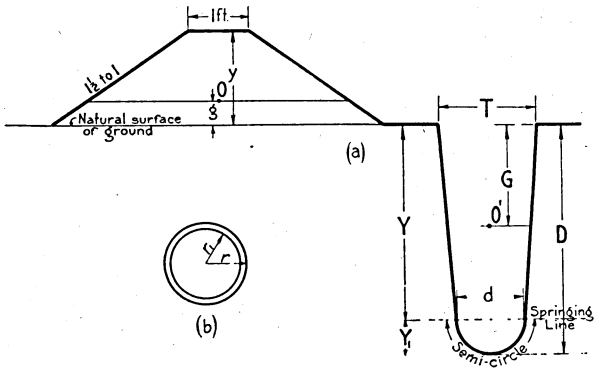
**In Table XIX only**

A = area of cross-section of trench or of spoil bank
a = area of cross-section of tile wall
r = outer radius of tile
$r_1$ = inner radius of tile
$\pi$ = ratio of circumference of a circle to its diameter (= 3.1416 approx.)
s = ratio of density of material in tile wall to density of ordinary excavated material
$0.12 = \frac{T-d}{Y}$, assumed constant rate of spread of trench cross-section from springing line to top




(a) TYPICAL CROSS SECTION OF SPOIL BANK AND TILE TRENCH FOR TILE LESS THAN 10 INCHES IN DIAMETER.
(b) TYPICAL CROSS SECTION OF TILE WALL.

Fig. 19a. Typical Cross-Section of Spoil Bank and Tile Trench for Tile Less Than 10 Inches in Diameter




(a) TYPICAL CROSS SECTION OF SPOIL BANK AND TILE TRENCH FOR TILE 10 INCHES IN DIAMETER AND LARGER.
(b) TYPICAL CROSS SECTION OF TILE WALL.

Fig. 19b. Typical Cross-Section of Spoil Bank and Tile Trench for Tile 10 Inches in Diameter and Larger

**Statement of formulas used in computing Table XIX from Figure 19b**

$$d = 115\% \text{ of outer diameter of tile} = 1.15 \times 2r \quad (1)$$

$$Y = D - d/2 = D - Y_1 \quad (2)$$

$$T = d + 0.12\ Y \quad (3)$$

$$A = \frac{\pi d^2}{8} + \frac{(d+T)\ Y}{2} = \tfrac{1}{2}\left[\pi Y_1^2 + (d+T)\ Y\right] \quad (4)$$

$$= (2T - 0.12\,G)\ G = 2TG - 0.12\,G^2 \quad (5)$$

$$= \frac{(2+3y)\ y}{2} = y + \frac{3y^2}{2} \quad (6)$$

$$= \left[2(1+3y) - 3g\right] g = 2(1+3y)\,g - 3g^2 \quad (7)$$

$$\text{From (5)},\ G = \frac{T - \sqrt{T^2 - 0.12\,A}}{0.12} \quad (8)$$

$$\text{From (6)},\ y = \frac{-1 + \sqrt{1+6A}}{3} \quad (9)$$

$$\text{From (7)},\ g = \frac{1+3y - \sqrt{(1+3y)^2 - 3A}}{3} \quad (10)$$

$$a = \pi\,(r^2 - r_1^2) = \pi\,(r - r_1)\,(r + r_1) \quad (11)$$

asD = work units per linear foot of trench due to lowering tile into trench (12)

A(g+G) = work units per linear foot of trench due to excavating trench (13)

A(g+G) + asD = total work units per linear foot of trench (14)

Table XVIII gives the values of the quantity $A(g+G) + asD$ for all sizes of tile from 4-inch to 24-inch and for all depths of trench from 3 to 12 feet. This table is a compilation of the data in the last column on the right in all the ten tables mentioned, like Table XIX, and of which Table XIX is one.

Figure 20, page 65, is plotted from the data of Table XX. The values given in Table XX are used in the computation of the final schedules, Tables XXI, XXII, and XXIII, as later shown under discussion of "Method of computation of final schedules."

**Computation of total work units.**—The items in Tables XVI, XVII, and XVIII, in the columns headed "Work units per linear foot," were read from Figure 20 according to the average cut recorded in Table XIX for each size of tile. The product of each of these values from Figure 20 by the corresponding linear feet of tile of the given size gives the total number of standard work units for that item of the job. All such products are shown in the column in Tables XVI, XVII, and XVIII, headed "Work units, total per item."

## METHOD OF COMPUTATION OF FINAL SCHEDULES

(Tables XXI, XXII, and XXIII)

**Hour-labor coefficients** (Work units per man hour).—Dividing the grand total standard work units in any class of trenching, as given in Tables XVI, XVII, and XVIII, by the grand total hours of trenching labor, as given in the same tables, gave the number of work units constituting an average hour of man labor in that type of digging. As shown under the several types in Tables XVI, XVII, and XVIII, these are as follows:

| | |
|---|---|
| For easy digging | 70 |
| For average digging | 60 |
| For hard digging | 43 |

Multiplying the successive items of work units per linear foot of trench (Table XX) by 100 and dividing these products through in succession by the foregoing hour labor coefficients for the given class of digging, gave the items in Tables XXI, XXII, and XXIII, pages 66, 67, and 68, respectively, for each size of tile and depth of trench. Figures 21, 22, and 23 were plotted from the data of Tables XXI, XXII, and XXIII, respectively.

## RELIABILITY OF TRENCHING SCHEDULES

These trenching schedules are independent of economic conditions and entirely dependent on the efficiency of labor. The data on which the schedules for easy and for hard digging are based are meager, but as they comprise all the exact data now available in these two classes of digging, the resulting schedules are the best to be had. If a greater mass of exact data becomes available in the future, it will simply serve to support or improve these schedules in proportion to the amount and exactness of the additional data presented. The schedule for average digging is backed by a mass of data which gives it decided stability and reliability as a basis for estimates and bids. The greater mass of digging is probably average, and schedules from this table should fit closely. If money values of trenching are wanted, they are also readily computed from the time schedules wherever the value of an hour of labor is known. For example, if at the given time, common tiling labor is worth 40 cents per hour and it is desired to know the right price for 100 feet of 6.5-foot trench for 10-inch tile, for average digging, Figure 22 shows the hours required to be 58. This, multiplied by 40 cents, gives the correct price, or $23.20.

If it is desired to include cost of board or contractor's profit, the bare *price of labor per hour* should be increased the proper percentage in each case.

It is evident that such a schedule can not be used to cover cases in which unusual difficulties occur or where plank stays or curbing must be placed, but even with these limitations this schedule will tend to lead to more balanced engineers' estimates and contractors' bids.

Some prefer tables to curves and Tables XXI, XXII, and XXIII can be used instead of the curves in Figures 21, 22, and 23.

## PRACTICAL ILLUSTRATION OF USE OF TRENCHING SCHEDULES

The following is an estimate of the time required to do the trenching, laying, and blinding of the tile on a small drainage system installed by hand on the Experimental Farm at Duluth, Minnesota, in the fall of 1924.

**Explanation of conditions.**—Most of this digging was in the hard, stony, clay soil of the Lake Superior region, some was in peat, and some was in mineral soil. The part of the main constructed of 8- and 12-inch tile was laid in the slope of an existing open ditch, later partly filled, whose bottom was only slightly over a foot above the grade of the tile. Hence the average cut was materially reduced from that indicated by the levels on the hubs which were on the high side of the

tile line, and most of the excavated material did not have to be lifted the full height of the trench into a high spoil bank but could simply be rolled over the side into the bottom of the ditch. A careful examination of these conditions and computations based on the existing physical facts showed the reduction from the normal lift to be about 25 per cent. Hence, for the 8- and 12-inch tile, the normal time of trenching to the average depth from tops of hubs was taken from the curves and reduced 25 per cent before extending.

**Details of estimate**

Total hrs.

**Small open ditch** below tile outlet, hard digging, 2098 cubic feet of excavation, 1.8 feet average lift; hence total time equals 2098 times 1.8 or a total of 3776 work units divided by 43 per hour of man labor..... 86

**Open intercepting ditches** at head of system, easy digging, 4722 cubic feet of excavation, 1.1 feet average lift; hence total time equals 4722 times 1.1, or a total of 5194 work units divided by 70 per hour of man labor..... 74

**Tile**

| Lin. ft. | Size | Av. cuts from hubs | Class of digging | Time per 100 ft. (from curves) | Adjustment | Adjusted hours Rate | Adjusted hours Total |
|---|---|---|---|---|---|---|---|
| | inches | feet | | hours | per cent | | |
| 600 | 12 | 3.00 | hard | 20 | —25 | 15 | 90 |
| 200 | 10 | under 3.00 | hard | 16 | .... | 16 | 32 |
| 1000 | 8 | under 3.00 | hard | 13 | —25 | 10 | 100 |
| 450 | 6 | 4.44 | easy | 13 | .... | .. | 59 |
| 565 | 5 & 6 | 3.00 | hard | 10 | .... | .. | 57 |
| 250 | 5 | under 3.00 | easy | 6 | .... | .. | 15 |
| 250 | 5 | 3.21 | easy | 7 | .... | .. | 17 |
| 400 | 5 | 3.44 | easy | 7 | .... | .. | 28 |
| 310 | 5 | 3.76 | easy | 9 | .... | .. | 28 |

Total hours for job..... 586
Total hours of man labor actually required..... 580

Error of estimate..... + 6
Slightly over 1 per cent.

## REFILLING TRENCHES

The refilling of the trenches may be done by various methods, the method adopted in any given case being mostly dependent on the size of the job to be done altho to some extent influenced by the character of the field surface and the governing lengths of the field laterals. It is convenient to figure the labor cost of filling trenches at so much per 100 linear feet according to size of tile and depth of trench, as the amount of labor required will vary almost exactly with the amount of material to be moved; but it is only slightly affected by the distance this material must be moved, as the only labor involved is in pushing the

spoil bank over to the trench, a comparatively short distance horizontally, gravity doing the rest of the moving. The work is usually done by the cheapest class of help. If the refilling is done with teams or machinery or both, it is difficult to reduce all the time spent to a man-hour basis. A close study of the data on these projects seemed to indicate that an arbitrary time unit of 1 team hour plus 1⅓ man hours is the most convenient and satisfactory for use on this cost element; hence that unit was established, with distribution of cost in both money and time extended in Table XXIV, page 70, in the same manner as with the elements previously discussed.

The labor of refilling trenches will vary considerably according to size of tile and depth of trench, as was the case with trenching, laying, and blinding, altho to a less extent and less intricately. The variation is a direct variation in terms of the cubic feet or cubic yards of material to be moved per unit length of trench. Therefore, it has seemed best in this case, also, to establish a time-cost schedule somewhat similar to that finally evolved for trenching, laying, and blinding. However, as the material does not have to be dug or lifted but simply pushed sidewise from a more or less loose spoil bank, the element of character of digging need not be considered, but it is necessary to determine the average number of cubic feet of earth moved per hour. The total volume of all trenches on all projects divided by the total number of hours required in refilling the trenches will give this average. Table XXV, page 72, gives the average cut, area of cross-section, and total volume of trench on each project for each size of tile and the total volume of all trenches on all projects. The resulting average number of cubic feet moved per hour unit is 489.4. This is so near to 490 that assuming it to be 490 will give a factor more convenient to handle without introducing an appreciable error.

If this factor (490) be successively divided into the areas of trench cross-section for the different sizes of tile and depths of trench shown in column "A," in Table XIX and the similar tables, and the resulting quotients each multiplied by 100, the successive results will be the average number of hour units required to fill 100 linear feet of trench for each given size of tile and depth of trench. Table XXVI, page 75, gives this information for sizes of tile from 4- to 24-inch and for depths of trench from 3 to 12 feet; and Figure 24 shows the same data in curves similar to those developed for trenching, laying, and blinding.

## OUTLET PROTECTION AND MISCELLANEOUS

Protection of outlet and miscellaneous expense may involve only extra material or both extra material and extra labor. The expense involved depends very largely on local conditions and consequently varies from little or nothing to a very appreciable figure, so the data on this element from any set of projects do not furnish conclusive information. The available data are given here, however, to make the whole fund of information as complete as possible. The cost of these elements in both money and time, distributed on the usual basis, is given in Tables XXVII and XXVIII, pages 76 and 78.

Altho actual costs do not directly involve the items of average cut, average gradient, and average size of tile, the information contained herein will not be complete or of its fullest value without the inclusion of data furnishing these three items, because depth of cut, gradient, and size of tile are essential elements of tile drainage design which are intimately bound up with the subject of cost. Therefore tables are included giving these data. The average cuts, classified according to size of tile and character of land surface, are shown in Table XXIX, page 80; and the average sizes of tile and average grades, classified according to character of land surface, are shown in Table XXX, page 87. Table XXXI, page 82, giving the approximate weight per linear foot of tile from 4-inch to 24-inch, inclusive, is also added because both are necessary and convenient to a full consideration of these cost data.

## PRACTICAL ILLUSTRATIONS OF THE USE OF THE TABLES OF COST DATA

The following examples illustrate a few of many ways in which the cost data in this bulletin may be used to obtain preliminary estimates of approximate accuracy, according to the amount of detail used in working them out.

### Assumed Details

Flat land
Average digging conditions

| | |
|---|---|
| Area of watershed on farm..... | 240 acres |
| Area of land drained..... | 125 acres |
| Area of land reclaimed ..... | 70 acres |

### Illustration of a Fairly Exact Method Such as an Engineer Would Be Likely to Use

This case seems somewhat similar to project 11; therefore, using project 11 as a guide:

Table XXX gives average size of main tile on this project as 12 inches.

Table XXIX gives average cut on main tile as 5.37 feet.

Table XXIX gives average cut for the small laterals as 3.53 feet.

Table XXXI gives average weight per foot of 12-inch tile as 43 pounds, of 5-inch tile as 10 pounds.

**Amount of Tile Required**—from Table VIII, Project 11

| 6 inches and under | over 6 inches |
|---|---|
| 240 acres at 144 = 34,560 lin. ft. | 240 acres at 40 = 9,600 lin. ft. |
| or 125 acres at 276 = 34,500 lin. ft. | or 125 acres at 78 = 9,750 lin. ft. |
| or 70 acres at 576 = 39,690 lin. ft. | or 70 acres at 160 = 11,200 lin. ft. |

These figures seem to indicate that the amount of reclaimed land is a poor index, probably on account of its great variation. Hence rejecting item 3 in both cases and taking the average of the other two gives:

34,530 lin. ft. of 5 in. at 10 lbs. per ft. = 345,300 lbs. or 172.66 tons
9,675 lin. ft. of 12 in. at 43 lbs. per ft. = 416,025 lbs. or 208.00 tons

Total 44,205 lin. ft. — 761,325 lbs. or 380.66 tons or 25.38 carloads

**Engineering and Supervision**

44,205 lin. ft. of tile at 11.22 hrs. per M. ft. (Table VI) at $1.01 per hr. (Table VI) ..... $500.94

**Tile**

44,205 lin. ft. at $56.59 per M. ft. (Table XI) ..... 2501.56

**Freight**

25.38 carloads at $10.69 per carload (Table XIII) ..... 271.31

**Haul and Distribution**

380.66 tons at 1.87 hr. units per ton (Table XIV) at $0.35 per hr. unit (Table XIV) ..... 249.14

**Trenching, Laying, and Blinding**

34,530 lin. ft. at 10.5 hrs. per 100 ft. (Table XXII for 5 in. tile av. cut 3.53) at $0.28 per hr. (Table XV) ..... $1015.18

9,675 lin. ft. at 47.0 hrs. per 100 ft. (Table XXII for 12 in. tile av. cut 5.37) at $0.28 per hr. (Table XV) ..... 1273.23

Total trenching, laying, and blinding ..... 2288.41

**Refilling Trenches**

34,530 lin. ft. of 5 in. av. cut 3.53 at 0.6 hr. unit per 100 ft. (Table XXVI) at $0.81 per hr. unit. (Table XXIV) ..... $167.82

9,675 lin. ft. of 12 in. av. cut 5.37 at 1.7 hr. units per 100 ft. (Table XXVI) at $0.81 per hr. unit. (Table XXIV) ..... 133.22

Total refill ..... 301.04

**Outlet Protection**

44,205 lin. ft. at $1.13 per M. ft. (Table XXVII)..... 49.95

**Miscellaneous**

None

Grand total cost..... $6162.35

If the same example be worked out by using the average units and rates for all flat land projects from the same tables, the factors and results will be as follows:

Lateral tile 5-inch., average cut 3:14 feet; main tile 14-inch, average cut 5.24 feet.

Weight of 14-inch concrete tile, 59 pounds per linear foot (Table XXXI).

**Amount of tile required** (rejecting the reclaimed land factor as before)

| 6 inches or less | | over 6 inches | |
|---|---|---|---|
| 240 acres at 180 = | 43,200 lin. ft. | 240 acres at 32 = | 7,680 lin. ft. |
| 125 acres at 264 = | 33,000 lin. ft. | 125 acres at 47 = | 5,875 lin. ft. |
| Average | 38,100 lin. ft. | Average | 6,778 lin. ft. |
| 38,100 lin. ft. at 10 lbs. = | 381,000 lbs. or 190.50 tons | | |
| 6,778 lin. ft. at 59 lbs. = | 399,902 lbs. or 199.95 tons | | |
| Totals 44,878 lin. ft. | 780,902 lbs. or 390.45 tons or 26.03 carloads | | |

**Engineering and Supervision**

44.878 × 10.17 × $0.86..... $ 392.51

**Tile**

44.878 × $50.58..... 2269.93

**Freight**

26.03 × $24.05..... 626.02

**Haul and Distribution**

44.878 × 24.20 × $0.35..... 380.11

**Trenching, Laying, and Blinding**

381.00 × 8.0 × $0.29..... $883.92

67.78 × 52.5 × $0.29..... 1031.95

Total ..... 1915.87

**Refilling Trenches**

381.00 × 0.5 × $0.80..... $152.40

67.78 × 2.0 × $0.80..... 108.45

Total ..... 260.85

**Outlet Protection**

44.878 × 1.10 × $0.90..... 44.43

**Miscellaneous**

None

Grand total cost..... $5889.72

This total, in comparison with the first computation with its more careful selection, is in error, but only about 4 per cent, which is close for an estimate.

The average money rates per hour herein used are the averages from the tables and are used only to illustrate the method. In actual cases these money rates per hour should be replaced by what are known, at the time, to be the prevailing local rates.

### Illustration of an Approximate Short Method Such as a Farmer Might Use

**To obtain approximate total cost,** again following project 11,

| | |
|---|---|
| 240 acres of watershed at $24.95 total cost per acre from Table III.... | $5988.00 |
| 125 acres drained at $47.97 total cost per acre from Table III.... | 5996.25 |
| Average ..... | $5992.13 |

Cost of tile, on same basis, from Table XI becomes

| | |
|---|---|
| 240 × $10.42..... | $2500.80 |
| or 125 × 20.04..... | 2505.00 |
| Average ..... | $2502.90 |

From Table IV referring to project 11, cost of tile represents 41.8 per cent of the total cost.

Hence total cost should be $\frac{2502.90}{0.418}$ or $5987.80.

Any of these four results is reasonably close to the standard established in the first example, the error in no case much exceeding 4½ per cent.

### Illustration of a Handy Method for the Contractor

Similarly, a contractor interested largely in the trenching labor might thus figure from the units for trenching, laying, and blinding, taking his units for flat land from Table XV.

| | |
|---|---|
| 240 acres at $9.35 per acre..... | $2244.00 |
| 125 acres at 17.99 per acre..... | 2248.75 |
| Average ..... | $2246.38 |

Table IV shows the item of trenching, laying, and blinding for project 11 to be 37.5 per cent of the total. Hence the total should be $\frac{2246.38}{0.375}$ or $5990.34, which is reasonably close.

### Illustration of a Handy Method for the Tile Manufacturer

A tile manufacturer would probably base his estimates on the weight of tile required, in tons, taking his units from Tables IX and XI thus:

| | |
|---|---|
| 240 × 1.50 tons × $6.94 per ton..... | $2498.40 |
| 125 × 2.89 tons × 6.94 per ton..... | 2507.07 |
| Average ..... | $2502.74 |

The cost of tile as shown above from Table IV is 41.8 per cent of the total cost, hence the total cost should be $\frac{2502.74}{0.418}$ or $5987.41.

The general assumption from any of the foregoing is that the total cost would be about $6000, which is probably about right for average conditions.

## SPECIAL CONDITIONS NOT COVERED

It should be borne in mind that schedules and unit costs here presented apply only to the actual work and materials on individual farm drainage and do not include contractor's profit, employees' liability insurance, or other special features caused by local, natural, or business conditions. If these must be considered, suitable allowance must be made for them.

## ACKNOWLEDGMENTS

Acknowledgments are due to John T. Stewart who, while agricultural engineer of this experiment station, collected a mass of valuable cost data which forms a very considerable portion of the material in this bulletin; to H. B. Walker, agricultural engineer of the Kansas State Agricultural Experiment Station, and E. R. Jones, agricultural engineer of the Wisconsin State Agricultural Experiment Station, for their constructive criticism and suggestions, particularly with reference to the development of the cost schedules for trenching, laying, and blinding; to George F. Krogh, of this division, for the drawings presented; and to farmers throughout the state whose hearty co-operation with the drainage staff made it possible to obtain a large part of the data presented in this bulletin.

TABLE I

LOCATION, DATE OF INSTALLATION, CLASSIFICATION OF LAND AFFECTED, AND DESCRIPTION OF SOIL AND CHARACTER OF DIGGING

| Project No. | Location | | Date of installation | | Surface classification of land | | | Character of soil and subsoil |
|---|---|---|---|---|---|---|---|---|
| | Town | County | Month | Year | Rolling | Flat | Peat | |
| 1 | Zumbra Heights | Carver | Aug.-Nov. | 1908 | X | | | Clayey moraines, some common marsh, peat pockets, some hardpan. Average digging |
| 2 | Opposite Halstad, Minn. | Trail, No. Dak., | May-June | 1909 | | X | | Lake bed clay, extra tight, near gumbo, wet and sticky. Average digging |
| 3 | Belle Plaine, Scott Co. | Carver | Sept.-Oct. | 1909 | X | | | Same as project 1 |
| 4 | St. Paul | Ramsey | Nov.-Dec.<br>May | 1909<br>1910 | | X | | Sandy loam underlaid with thin layer of clay, then dry sand and gravel; gravel slightly cemented in spots. Average digging |
| 5 | Grand Rapids | Itasca | July-Sept. | 1910 | | X | | Overridden moraines; marsh and peat pockets, some deep peat, some very stony clay; heavy seepage. Digging varied |
| 6 | Oakland | Freeborn | Oct.-Nov. | 1910 | | X | | Black mucky loam over lake bed clay, some sticky gumbo. Average digging |
| 7 | Osakis | Douglas | May-June | 1911 | X | | | Boulder clay and stony ground moraines. Digging hard, largely pick work |
| 8 | Faribault | Rice | July-Nov.<br>June-Aug. | 1911<br>1912 | X | | | Same as projects 1 and 3 |
| 9 | Fargo, No. Dak. | Cass | June-Aug. | 1915 | | X | | Same as project 2 |
| 10 | Duluth | St. Louis | Sept-Nov.<br>May-June<br>Oct. | 1915<br>1916<br>1921 | X | | | Very hard red clay mixed with fragments of trap rock. Digging very hard, much pick work |

TABLE I—*Continued*

LOCATION, DATE OF INSTALLATION, CLASSIFICATION OF LAND AFFECTED, AND DESCRIPTION OF SOIL AND CHARACTER OF DIGGING

| Project No. | Location | | Date of installation | | Surface classification of land | | | Character of soil and subsoil |
|---|---|---|---|---|---|---|---|---|
| | Town | County | Month | Year | Rolling | Flat | Peat | |
| 11 | Moorhead | Clay | Sept.-Nov. | 1916 | | X | | Lake bed clay, very sticky after rains. Average digging |
| 12 | Glyndon | Clay | Nov. | 1917 | | | | Same as project 11 |
| | | | May-Nov. | 1918 | | X | | |
| 13 | Coon Creek | Anoka | Aug.-Oct. | 1918 | | | X | Peat 4 to 6 feet deep underlaid by windblown sand to an indefinite depth. Digging mostly easy except where heavy seepage caused caving and running in of thin mud |
| | | | April-May | 1919 | | | | |
| | | | Nov.-Dec. | 1921 | | | | |
| | | | May-June | 1922 | | | | |
| 14 | Minneapolis | Hennepin | May | 1919 | X | | | Loose black loam over gravelly boulder clay, on a slope of a high moraine. Average digging |
| 15 | Newmarket | Scott | July-Sept. | 1919 | X | | | Same as project 1 |
| 16 | Fens | St. Louis | May-June | 1919 | | | X | Deep peat filled with tamarack roots and stumps. Easy digging apart from roots and stumps |
| 17 | Paynesville | Stearns | June-Sept. | 1921 | X | | | Boulder clay under peat blanket 6 to 30 inches deep. Digging average, but sticky after rains |
| 18 | Meadowlands | St. Louis | Oct.-Nov. | 1921 | | X | | Sandy lake bed till with light peat layers in pockets, dry. Better than average digging |
| | Totals | 14 | Apr.-Nov. | 1908-22 | 8 | 8 | 2 | |

* Classification of land on any project is indicated in the proper column by X.

## TABLE II

AREAS, IN ACRES, ACCORDING TO DRAINAGE CHARACTER OF SURFACE

| Farm project No. | All projects | | | Rolling land | | | Flat land | | | Peat land | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Water-shed on farm | Drain-ed | Re-claim-ed | Water-shed on farm | Drain-ed | Re-claim-ed | Water-shed on farm | Drain-ed | Re-claim-ed | Water-shed on farm | Drain-ed | Re-claim-ed |
| 1..... | 73 | 15 | 10 | 73 | 15 | 10 | | | | | | |
| 2..... | 160 | 160 | 80 | .. | .. | .. | 160 | 160 | 80 | | | |
| 3..... | 76 | 14 | 14 | 76 | 14 | 14 | | | | | | |
| 4..... | 40 | 35 | 5 | .. | .. | .. | 40 | 35 | 5 | | | |
| 5..... | 185 | 120 | 100 | .. | .. | .. | 185 | 120 | 100 | | | |
| 6..... | 120 | 120 | 95 | .. | .. | .. | 120 | 120 | 95 | | | |
| 7..... | 120 | 20 | 8 | 120 | 20 | 8 | | | | | | |
| 8..... | 237 | 56 | 56 | 237 | 56 | 56 | | | | | | |
| 9..... | 95 | 95 | 32 | .. | .. | .. | 95 | 95 | 32 | | | |
| 10..... | 160 | 40 | 13 | 160 | 40 | 13 | | | | | | |
| 11..... | 300 | 156 | 76 | .. | .. | .. | 300 | 156 | 76 | | | |
| 12..... | 255 | 100 | 75 | .. | .. | .. | 255 | 100 | 75 | | | |
| 13..... | 40 | 28 | 28 | .. | .. | .. | .. | .. | .. | 40 | 28 | 28 |
| 14..... | 3½ | 2 | 1 | 3½ | 2 | 1 | | | | | | |
| 15..... | 500 | 170 | 120 | 500 | 170 | 120 | | | | | | |
| 16..... | 20 | 15 | 15 | .. | .. | .. | .. | .. | .. | 20 | 15 | 15 |
| 17..... | 139 | 35 | 35 | 139 | 35 | 35 | | | | | | |
| 18..... | 7 | 5 | 2½ | .. | .. | .. | 7 | 5 | 2½ | | | |
| Totals.... | 2530½ | 1186 | 765½ | 1308½ | 352 | 257 | 1162 | 791 | 465½ | 60 | 43 | 43 |

## TABLE III

TOTAL COSTS AND COSTS PER ACRE PER PROJECT

| Farm project No. | All projects | | | | Rolling land | | | | Flat land | | | | Peat land | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total cost | Cost per acre | | | Total cost | Cost per acre | | | Total cost | Cost per acre | | | Total cost | Cost per acre | | |
| | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed |
| 1..... | $ 615.00 | $ 8.42 | $ 41.00 | $ 61.50 | $ 615.00 | $ 8.42 | $ 41.00 | $ 61.50 | | | | | | | | |
| 2..... | 4,672.08 | 29.20 | 29.20 | 58.40 | ..... | .... | .... | .... | $4,672.08 | $29.20 | $ 29.20 | $ 58.40 | | | | |
| 3..... | 758.12 | 9.98 | 54.15 | 54.15 | 758.12 | 9.98 | 54.15 | 54.15 | | | | | | | | |
| 4..... | 427.24 | 10.68 | 12.21 | 85.48 | ..... | .... | .... | .... | 427.24 | 10.68 | 12.21 | 85.48 | | | | |
| 5..... | 3,761.99 | 20.34 | 31.35 | 37.62 | ..... | .... | .... | .... | 3,761.99 | 20.34 | 31.35 | 37.62 | | | | |
| 6..... | 1,544.77 | 12.87 | 12.87 | 16.26 | ..... | .... | .... | .... | 1,544.77 | 12.87 | 12.87 | 16.26 | | | | |
| 7..... | 1,288.30 | 10.74 | 64.42 | 161.04 | 1,288.30 | 10.74 | 64.42 | 161.04 | | | | | | | | |
| 8..... | 3,529.27 | 14.89 | 63.02 | 63.02 | 3,529.27 | 14.89 | 63.02 | 63.02 | | | | | | | | |
| 9..... | 4,740.67 | 49.90 | 49.90 | 148.15 | ..... | .... | .... | .... | 4,740.67 | 49.90 | 49.90 | 148.15 | | | | |
| 10..... | 2,791.52 | 17.45 | 69.79 | 214.73 | 2,791.52 | 17.45 | 69.79 | 214.73 | | | | | | | | |
| 11..... | 7,483.74 | 24.95 | 47.97 | 98.47 | ..... | .... | .... | .... | 7,483.74 | 24.95 | 47.97 | 98.47 | | | | |
| 12..... | 10,168.93 | 39.88 | 101.69 | 135.59 | ..... | .... | .... | .... | 10,168.93 | 39.88 | 101.69 | 135.59 | | | | |
| 13..... | 2,932.00 | 73.30 | 104.71 | 104.71 | ..... | .... | .... | .... | ..... | .... | .... | .... | $2,932.00 | $73.30 | $104.71 | $104.71 |
| 14..... | 261.57 | 74.73 | 130 79 | 261.57 | 261.57 | 74.73 | 130.79 | 261.57 | | | | | | | | |
| 15..... | 9,065.27 | 18.13 | 53.33 | 75.54 | 9,065.27 | 18.13 | 53.33 | 75.54 | | | | | | | | |
| 16..... | 1,038.13 | 51.91 | 69.21 | 69.21 | ..... | .... | .... | .... | ..... | .... | .... | .... | 1,038.13 | 51.91 | 69.21 | 69.21 |
| 17..... | 3,749.50 | 26.97 | 107.13 | 107.13 | 3,749.50 | 26.97 | 107.13 | 107.13 | | | | | | | | |
| 18..... | 277.92 | 39.70 | 55.58 | 111.16 | ..... | .... | .... | .... | 277.92 | 39.70 | 55.58 | 111.16 | | | | |
| Totals.. | $59,106.02 | ..... | .... | .... | $22,058.55 | .... | .... | .... | $33,077.34 | .... | .... | .... | $3,970.13 | | | |
| Averages | ..... | $23.36 | $49.84 | $77.21 | ..... | $16.86 | $62.67 | $101.78 | ..... | $28.47 | $41.82 | $71.06 | ..... | $66.17 | $92.33 | $92.33 |

## TABLE IV

COST OF EACH ELEMENT PER PROJECT AND PERCENTAGE THAT EACH ELEMENT REPRESENTS OF THE TOTAL COST

| Farm project No. | Total cost | Engineering and supervision | | Tile | | Freight | | Haul and distribution | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cost | Per cent | Cost | Per cent | Cost | Per cent | Cost | Per cent |
| **Rolling Land** | | | | | | | | | |
| 1..... | $ 615.00 | $ 50.00 | 8.1 | $ 171.65 | 27.9 | $ 55.97 | 9.1 | $ 24.48 | 4.0 |
| 3..... | 758.12 | 104.35 | 13.8 | 166.97 | 22.0 | 37.02 | 4.9 | 68.28 | 9.0 |
| 7..... | 1,288.30 | 163.17 | 12.6 | 407.03 | 31.6 | 150.39 | 11.7 | 66.88 | 5.2 |
| 8..... | 3,529.27 | 215.75 | 6.1 | 1,198.45 | 34.0 | 277.51 | 7.9 | 198.00 | 5.6 |
| 10..... | 2,791.52 | 342.76 | 12.3 | 278.10 | 10.0 | 301.79 | 10.8 | 133.10 | 4.8 |
| 14..... | 261.57 | 56.05 | 21.4 | 54.12 | 20.7 | ..... | .... | 30.00 | 11.5 |
| 15..... | 9,065.27 | 947.20 | 10.4 | 2,589.36 | 28.6 | 369.48 | 4.1 | 500.30 | 5.5 |
| 17..... | 3,749.50 | 214.07 | 5.7 | 1,278.11 | 34.1 | 294.29 | 7.9 | 330.64 | 8.8 |
| Totals... | $22,058.55 | $2,093.35 | .... | $ 6,143.79 | .... | $1,486.45 | .... | $1,351.68 | .... |
| Av. per cents ..... | | ..... | 9.5 | ..... | 27.8 | ..... | 6.8 | ..... | 6.1 |
| **Flat Land** | | | | | | | | | |
| 2..... | $ 4,672.08 | $ 128.50 | 2.7 | $ 1,833.19 | 39.2 | $ 867.68 | 18.6 | $ 371.87 | 8.0 |
| 4..... | 427.24 | 39.00 | 9.1 | 86.91 | 20.3 | 20.79 | 4.9 | 10.13 | 2.4 |
| 5..... | 3,761.99 | 234.82 | 6.3 | 1,589.13 | 42.2 | 572.69 | 15.2 | 180.52 | 4.8 |
| 6..... | 1,544.77 | 157.20 | 10.2 | 406.17 | 26.3 | 46.03 | 3.0 | 182.00 | 11.7 |
| 9..... | 4,740.67 | 216.08 | 4.6 | 1,211.25 | 25.5 | 587.16 | 12.4 | 118.25 | 2.5 |
| 11..... | 7,483.74 | 625.00 | 8.4 | 3,126.58 | 41.8 | 320.65 | 4.3 | 292.72 | 3.9 |
| 12..... | 10,168.93 | 722.25 | 7.1 | 4,138.24 | 40.7 | 386.74 | 3.8 | 899.22 | 8.8 |
| 18..... | 277.92 | 42.32 | 15.2 | 68.38 | 24.6 | 72.62 | 26.1 | 10.20 | 3.7 |
| Totals... | $33,077.34 | $2,165.17 | .... | $12,459.85 | .... | $2,874.36 | .... | $2,064.91 | .... |
| Av. per cents ..... | | ..... | 6.6 | ..... | 37.7 | ..... | 8.7 | ..... | 6.2 |
| **Peat Land** | | | | | | | | | |
| 13..... | $ 2,932.00 | $ 454.30 | 15.5 | $ 498.41 | 17.0 | $ 164.86 | 5.6 | $ 122.40 | 4.2 |
| 16..... | 1,038.13 | 212.84 | 20.5 | 136.78 | 13.2 | 43.16 | 4.2 | 18.00 | 1.7 |
| Totals... | $ 3,970.13 | $ 667.14 | .... | $ 635.19 | .... | $ 208.02 | .... | $ 140.40 | .... |
| Av. per cents ..... | | ..... | 16.8 | ..... | 16.0 | ..... | 5.2 | ..... | 3.5 |
| Grand totals.. | $59,106.02 | $4,925.66 | .... | $19,238.83 | .... | $4,568.83 | .... | $3,556.99 | .... |
| Grand av. per cents ..... | | ..... | 8.3 | ..... | 32.5 | ..... | 7.7 | ..... | 6.0 |

TABLE IV—*Continued*

COST OF EACH ELEMENT PER PROJECT AND PERCENTAGE THAT EACH ELEMENT REPRESENTS OF THE TOTAL COST

| Farm project No. | Trenching, laying, and blinding | | Refilling trenches | | Outlet protection | | Miscellaneous | |
|---|---|---|---|---|---|---|---|---|
| | Cost | Per cent | Cost | Per cent | Cost | Per cent | Cost | Per cent |
| **Rolling Land** | | | | | | | | |
| 1 | $ 256.00 | 41.6 | $ 39.36 | 6.4 | ..... | ... | $ 17.54 | 2.9 |
| 3 | 316.50 | 41.7 | 65.00 | 8.6 | | | | |
| 7 | 415.97 | 32.3 | 47.36 | 3.7 | ..... | ... | 37 50 | 2.9 |
| 8 | 1,424.09 | 40.3 | 132.60 | 3.8 | $21.50 | 0.6 | 61.37 | 1.7 |
| 10 | 1,515.76 | 54.3 | 207.61 | 7.4 | 12.40 | 0.4 | | |
| 14 | 90.00 | 34.4 | 12.00 | 4.6 | 19.40 | 7.4 | | |
| 15 | 4,296.63 | 47.4 | 289.80 | 3.2 | 72.50 | 0.8 | | |
| 17 | 1,561.23 | 41.6 | 34.08 | 0.9 | 37.08 | 1.0 | | |
| Totals | $ 9,876.18 | .... | $ 827.81 | .... | $162.88 | ... | $116.41 | ... |
| Av. per cents | ..... | 44.8 | ..... | 3.8 | ..... | 0.7 | ..... | 0.5 |
| **Flat Land** | | | | | | | | |
| 2 | $1,378.34 | 29.5 | $ 67.50 | 1.5 | $ 25.00 | 0.5 | | |
| 4 | 221.35 | 51.8 | 36.00 | 8.4 | 13.06 | 3.1 | | |
| 5 | 1,115.00 | 29.6 | 42.08 | 1.1 | 27.75 | 0.8 | | |
| 6 | 670.37 | 43.4 | 57.00 | 3.7 | 26.00 | 1.7 | | |
| 9 | 2,142.30 | 45.2 | 403.60 | 8.5 | 62.03 | 1.3 | | |
| 11 | 2,806.29 | 37.5 | 250.00 | 3.3 | 62.50 | 0.8 | | |
| 12 | 3,656.48 | 36.0 | 340.00 | 3.3 | 26.00 | 0.3 | | |
| 18 | 80.50 | 29.0 | 3.90 | 1.4 | | | | |
| Totals | $12,070.63 | .... | $1,200.08 | .... | $242.34 | | | |
| Av. per cents | ..... | 36.5 | ..... | 3.6 | ..... | 0.7 | | |
| **Peat Land** | | | | | | | | |
| 13 | $1,110.08 | 37.9 | $ 196.04 | 6.7 | $ 37.91 | 1.3 | $348.00 | 11.8 |
| 16 | 376.00 | 36.2 | 50.00 | 4.8 | ..... | ... | 201.35 | 19.4 |
| Totals | $1,486.08 | .... | $ 246.04 | .... | $ 37.91 | ... | $549.35 | |
| Av. per cents | ..... | 37.4 | ..... | 6.2 | ..... | 1.0 | ..... | 13.9 |
| Grand totals | $23,432.89 | .... | $2,273.93 | .... | $443.12 | ... | $665.76 | |
| Grand av. per cents | ..... | 39.7 | ..... | 3.9 | ..... | 0.8 | ..... | 1.1 |

TABLE V

TIME, IN HOURS, FOR LABOR ITEMS FOR EACH PROJECT AND FOR ALL PROJECTS

| Farm project No. | Engineering and supervision | Haul and distribution of tile | | | Trenching, laying, and blinding | | | |
|---|---|---|---|---|---|---|---|---|
| | Man hours | Man hours | Team hours | Totals reduced to man hours | Man hours | Team hours | Machine hours | Totals reduced to man hours |
| **Rolling Land** | | | | | | | | |
| 1 | 40* | 105 | 25 | 130 | 1,300 | .... | .... | 1,300 |
| 3 | 130 | 190 | 190 | 380 | 910 | .... | .... | 910 |
| 7 | 185 | 170 | 170 | 340 | 1,555 | .... | .... | 1,555 |
| 8 | 310 | 395 | 395 | 790† | 4,010 | .... | .... | 4,010 |
| 10 | 175 | 340 | 330 | 670 | 3,072 | .... | .... | 3,072 |
| 14 | 75 | 30 | 30 | 60 | 100 | .... | .... | 100 |
| 15 | 1,560 | 770 | 770 | 1,540 | 5,420 | .... | .... | 5,420† |
| 17 | 130 | 570 | 530 | 1,100 | 2,350 | 10 | .... | 2,360 |
| Totals | 2,605 | 2,570 | 2,440 | 5,010 | 18,717 | 10 | .... | 18,727 |
| **Flat Land** | | | | | | | | |
| 2 | 270† | 780 | 520 | 1,300 | 8,120 | 150 | .... | 8,270 |
| 4 | 80 | 25 | 20 | 45 | 540 | .... | .... | 540 |
| 5 | 300‡ | 390 | 390 | 780‡ | 3,100 | 230 | .... | 3,330* |
| 6 | 230 | 520 | 520 | 1,040 | 1,990 | 40 | .... | 2,030 |
| 9 | 130 | 100 | 100 | 200† | 6,900 | 400 | 200§ | 8,180* |
| 11 | 620 | 440 | 400 | 840† | 2,260 | 60 | 900‖ | 9,800† |
| 12 | 840 | 1,645 | 1,085 | 2,730 | 2,400 | 600 | 800‖ | 9,720† |
| 18 | 35 | 15 | 10 | 25 | 230 | .... | .... | 230 |
| Totals | 2,505 | 3,915 | 3,045 | 5,960 | 25,540 | 1,480 | 1,900 | 42,180 |
| **Peat Land** | | | | | | | | |
| 13 | 450 | 210 | 210 | 420 | 1,288 | .... | .... | 1,288 |
| 16 | 160 | 20 | 20 | 40 | 488 | .... | .... | 488 |
| Totals | 610 | 230 | 230 | 460 | 1,776 | .... | .... | 1,776 |
| Grand totals | 5,720 | 6,715 | 5,715 | 11,430 | 46,033 | 1,490 | 1,900 | 62,683 |

* Partly estimated.

† Estimated.

‡ A small part estimated.

§ Horse-drawn machine—1 machine hour reckoned as equal to 4.4 man hours.

‖ Gas-power machine—1 machine hour reckoned as equal to 8.4 man hours.

TABLE V—*Continued*

TIME, IN HOURS, FOR LABOR ITEMS FOR EACH PROJECT AND FOR ALL PROJECTS

| Farm project No. | Refilling trenches | | | | Outlet protection | | | Miscellaneous |
|---|---|---|---|---|---|---|---|---|
| | Man hours | Team hours | Machine hours | Totals reduced to team hours + 1⅓ man hr.¶ | Man hours | Team hours | Totals reduced to man hours | Man hours |
| | | | | Rolling Land | | | | |
| 1 | 160 | 65 | ... | 92 | | | | |
| 3 | 210 | 140 | ... | 149 | | | | |
| 7 | 130 | 110 | ... | 104† | | | | |
| 8 | 310 | 210 | ... | 221 | 40 | 10 | 50 | 200 |
| 10 | 560 | 350 | ... | 385 | | | | |
| 14 | 60 | ... | ... | 23 | 10 | .. | 10 | |
| 15 | 430 | 400 | ... | 361† | | | | |
| 17 | 90 | ... | 20 | 94 | | | | |
| Totals | 1,950 | 1,275 | 20 | 1,429 | 50 | 10 | 60 | 200 |
| | | | | Flat Land | | | | |
| 2 | 250 | 200 | ... | 194† | 70 | 10 | 80 | |
| 4 | 180 | ... | ... | 67† | 10 | .. | 10 | |
| 5 | 120 | 80 | ... | 85* | 55 | 15 | 70‡ | |
| 6 | 180 | 120 | ... | 127 | 30 | 15 | 45 | |
| 9 | 410 | 390 | ... | 349† | 20 | .. | 20† | |
| 11 | 440 | 285 | ... | 307† | | | | |
| 12 | 170 | ... | 85 | 319† | 40 | 5 | 45† | |
| 18 | 60 | 60 | ... | 53 | | | | |
| Totals | 1,810 | 1,135 | 85 | 1,501 | 225 | 45 | 270 | |
| | | | | Peat Land | | | | |
| 13 | 225 | ... | ... | 84 | 10 | .. | 10 | 270 |
| 16 | 70 | ... | ... | 26 | .. | .. | .. | 84 |
| Totals | 295 | ... | ... | 110 | 10 | .. | 10 | 354 |
| Grand totals | 4,055 | 2,410 | 105 | 3,040 | 285 | 55 | 340 | 554 |

* Partly estimated.

† Estimated.

‡ A small part estimated.

§ Horse-drawn machine—1 machine hour reckoned as equal to 4.4 man hours.

‖ Gas-power machine—1 machine hour reckoned as equal to 8.4 man hours.

¶ Total results indicated that each team hour also required 1⅓ man hours, hence the unit used.

TABLE VI

ENGINEERING AND SUPERVISION COST IN MONEY AND IN TIME PER MAN HOUR, PER ACRE, PER 1000 LINEAR FEET, PER TON AND PER CARLOAD OF TILE

| Farm project No. | Cost in dollars | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Per hour | Per acre | | | Per | | |
| | | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | | |
| 1..... | $ 50.00 | $1.25 | $0.68 | $3.33 | $5.00 | $5.56 | $1.34 | $20.08 |
| 3..... | 104.35 | 0.80 | 1.37 | 7.45 | 7.45 | 16.60 | 3.38 | 50.90 |
| 7..... | 163.17 | 0.88 | 1.36 | 8.16 | 20.40 | 16.88 | 2.60 | 39.06 |
| 8..... | 215.75 | 0.70 | 0.91 | 3.85 | 3.85 | 7.86 | 1.12 | 16.87 |
| 10..... | 342.76 | 1.96 | 2.14 | 8.57 | 26.37 | 27.47 | 4.20 | 62.42 |
| 14..... | 56.05 | 0.75 | 16.01 | 28.03 | 56.05 | 33.97 | 7.55 | 113.23 |
| 15..... | 947.20 | 0.61 | 1.89 | 5.57 | 7.89 | 16.87 | 3.08 | 46.14 |
| 17..... | 214.07 | 1.65 | 1.54 | 6.12 | 6.12 | 13.79 | 1.12 | 16.72 |
| Totals..... | $2,093.35 | .... | .... | .... | .... | .... | .... | ..... |
| Averages.... | ..... | $0.80 | $1.60 | $5.94 | $8.14 | $15.17 | $2.30 | $34.41 |
| **Flat Land** | | | | | | | | |
| 2..... | $ 128.50 | $0.48 | $0.80 | $0.80 | $1.61 | $3.60 | $0.51 | $ 7.67 |
| 4..... | 39.00 | 0.49 | 0.98 | 1.11 | 7.80 | 9.15 | 2.25 | 33.77 |
| 5..... | 234.82 | 0.78 | 1.27 | 1.96 | 2.35 | 9.15 | 1.06 | 15.94 |
| 6..... | 157.20 | 0.68 | 1.31 | 1.31 | 1.66 | 7.95 | 1.84 | 27.65 |
| 9..... | 216.08 | 1.66 | 2.27 | 2.27 | 6.75 | 4.65 | 1.03 | 15.46 |
| 11..... | 625.00 | 1.01 | 2.08 | 4.01 | 8.22 | 11.31 | 1.39 | 20.83 |
| 12..... | 722.25 | 0.86 | 2.83 | 7.22 | 9.63 | 12.90 | 1.33 | 19.96 |
| 18..... | 42.32 | 1.21 | 6.03 | 8.46 | 16.93 | 12.82 | 2.69 | 40.48 |
| Totals..... | $2,165.17 | .... | .... | .... | .... | .... | .... | ..... |
| Averages.... | ..... | $0.86 | $1.86 | $2.74 | $4.65 | $ 8.79 | $1.21 | $18.11 |
| **Peat Land** | | | | | | | | |
| 13..... | $ 454.30 | $1.01 | $11.36 | $16.23 | $16.23 | $31.83 | $6.23 | $ 93.48 |
| 16..... | 212.84 | 1.33 | 10.64 | 14.19 | 14.19 | 51.04 | 11.34 | 170.14 |
| Totals..... | $ 667.14 | .... | .... | .... | .... | .... | .... | ..... |
| Averages.... | ..... | $1.09 | $11.12 | $15.51 | $15.51 | $36.17 | $7.28 | $109.18 |
| Grand totals.. | $4,925.66 | .... | .... | .... | .... | .... | .... | ..... |
| Grand averages ..... | ..... | $0.86 | $1.95 | $4.15 | $6.43 | $12.23 | $1.65 | $26.41 |

TABLE VI—*Continued*

ENGINEERING AND SUPERVISION COST IN MONEY AND IN TIME PER MAN HOUR, PER ACRE, PER 1000 LINEAR FEET, PER TON AND PER CARLOAD OF TILE

| Farm project No. | Time in hours: Total | Per acre: Of watershed on farm | Per acre: Drained | Per acre: Reclaimed | Per: 1000 lin. ft. of tile | Per: Ton of tile | Per: Carload of tile |
|---|---|---|---|---|---|---|---|
| **Rolling Land** | | | | | | | |
| 1 | 40 | 0.55 | 2.67 | 4.00 | 4.55 | 1.07 | 16.06 |
| 3 | 130 | 1.71 | 9.29 | 9.29 | 20.68 | 4.22 | 63.41 |
| 7 | 185 | 1.54 | 9.25 | 23.12 | 19.14 | 2.95 | 44.26 |
| 8 | 310 | 1.31 | 5.54 | 5.54 | 11.30 | 1.62 | 24.24 |
| 10 | 175 | 1.09 | 4.37 | 13.46 | 14.02 | 2.14 | 31.88 |
| 14 | 75 | 21.43 | 37.50 | 75.00 | 45.45 | 10.10 | 150.00 |
| 15 | 1,560 | 3.12 | 9.18 | 13.00 | 27.79 | 5.07 | 75.99 |
| 17 | 130 | 0.94 | 3.71 | 3.71 | 8.37 | 0.68 | 10.16 |
| Totals | 2,605 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 1.99 | 7.40 | 10.14 | 18.88 | 2.86 | 42.82 |
| **Flat Land** | | | | | | | |
| 2 | 270 | 1.69 | 1.69 | 3.38 | 7.57 | 1.08 | 16.13 |
| 4 | 80 | 2.00 | 2.29 | 16.00 | 18.78 | 4.62 | 68.97 |
| 5 | 300 | 1.62 | 2.50 | 3.00 | 11.69 | 1.36 | 20.37 |
| 6 | 230 | 1.92 | 1.92 | 2.42 | 11.63 | 2.70 | 40.42 |
| 9 | 130 | 1.37 | 1.37 | 4.06 | 2.80 | 0.62 | 9.30 |
| 11 | 620 | 2.07 | 3.97 | 8.16 | 11.22 | 1.38 | 20.67 |
| 12 | 840 | 3.29 | 8.40 | 11.20 | 15.00 | 1.55 | 23.21 |
| 18 | 35 | 5.00 | 7.00 | 14.00 | 10.61 | 2.23 | 33.33 |
| Totals | 2,505 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 2.16 | 3.17 | 5.38 | 10.17 | 1.40 | 20.96 |
| **Peat Land** | | | | | | | |
| 13 | 450 | 11.25 | 16.07 | 16.07 | 31.52 | 6.17 | 92.59 |
| 16 | 160 | 8.00 | 10.67 | 10.67 | 38.37 | 8.52 | 128.00 |
| Totals | 610 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 10.16 | 14.19 | 14.19 | 33.07 | 6.65 | 99.84 |
| Grand totals | 5,720 | .... | .... | .... | ..... | .... | ..... |
| Grand averages | .... | 2.26 | 4.82 | 7.47 | 14.20 | 1.92 | 30.67 |

## TABLE VII

LINEAR FEET OF DIFFERENT SIZES OF TILE ON EACH PROJECT AND ON ALL PROJECTS

| Farm project No. | 4-in. | 5-in. | 6-in. | 7-in. | 8-in. | 9-in. | 10-in. | 12-in. | 14-in. | 15-in. | 16-in. | 18-in. | 20-in. | 22-in. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rolling Land** | | | | | | | | | | | | | | | |
| 1 | 3,000 | 3,600 | 500 | 900 | 800 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 8,800 |
| 3 | 2,710 | 630 | 770 | .... | 2,175 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 6,285 |
| 7 | 2,386 | 745 | 2,502 | .... | 2,365 | .... | 1,270 | 400 | .... | .... | .... | .... | .... | .... | 9,668 |
| 8 | 10,173 | 7,790 | 2,850 | 1,190 | 800 | .... | 300 | 2,090 | 200 | .... | 1,500 | 640 | .... | .... | 27,443 |
| 10 | .... | 7,953 | 951 | .... | 1,200 | .... | 1,214 | 1,160 | .... | .... | .... | .... | .... | .... | 12,478 |
| 14 | .... | 1,650 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1,650 |
| 15 | .... | 41,540 | 6,191 | 1,750 | 1,150 | 1,300 | 400 | 2,500 | 1,110 | 155 | .... | 35 | .... | .... | 56,131 |
| 17 | .... | 5,638 | 3,475 | 700 | 555 | .... | 1,100 | 2,177 | .... | .... | 1,880 | .... | .... | .... | 15,525 |
| Totals | 18,269 | 69,546 | 17,239 | 4,540 | 9,045 | 1,300 | 4,284 | 8,237 | 1,310 | 155 | 3,380 | 675 | .... | ... | 137,980 |
| **Flat Land** | | | | | | | | | | | | | | | |
| 2 | 24,250 | 6,450 | .... | .... | .... | .... | .... | .... | .... | 1,000 | 1,500 | 2,465 | .... | .... | 35,665 |
| 4 | 2,075 | 710 | 850 | 450 | 175 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,260 |
| 5 | 18,625 | 1,320 | 1,120 | .... | .... | .... | .... | .... | .... | .... | 2,100 | 2,500 | .... | .... | 25,665 |
| 6 | 12,130 | 2,320 | 2,700 | .... | 1,355 | .... | 1,275 | .... | .... | .... | .... | .... | .... | .... | 19,780 |
| 9 | 26,000 | 9,857 | 6,800 | .... | 1,040 | .... | 760 | 450 | 1,500 | .... | .... | .... | .... | .... | 46,407 |
| 11 | .... | 35,982 | 7,123 | .... | 2,675 | .... | 2,900 | 6,000 | 200 | .... | .... | 330 | .... | 40 | 55,250 |
| 12 | .... | 43,465 | 3,995 | 160 | 1,248 | .... | 1,990 | 542 | 400 | 500 | 1,080 | 270 | 1,542 | 808 | 56,000 |
| 18 | .... | 3,300 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3,300 |
| Totals | 83,080 | 103,404 | 22,588 | 610 | 6,493 | .... | 6,925 | 6,992 | 2,100 | 1,500 | 4,680 | 5,565 | 1,542 | 848 | 246,327 |
| **Peat Land** | | | | | | | | | | | | | | | |
| 13 | .... | 11,925 | 400 | 700 | 1,250 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 14,275 |
| 16 | .... | 4,170 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 4,170 |
| Totals | .... | 16,095 | 400 | 700 | 1,250 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 18,445 |
| Grand totals | 101,349 | 189,045 | 40,227 | 5,850 | 16,788 | 1,300 | 11,209 | 15,229 | 3,410 | 1,655 | 8,060 | 6,240 | 1,542 | 848 | 402,752 |

## TABLE VIII

LINEAR FEET OF TILE ON EACH PROJECT AND ON ALL PROJECTS (6-INCH AND LESS, AND OVER 6-INCH)

| Farm project No. | 6-inch and less | | | | Over 6-inch | | | | Grand total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Per acre | | | Total | Per acre | | | Total | Per acre | | |
| | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed |
| **Rolling Land** | | | | | | | | | | | | |
| 1 | 7,100 | 97 | 473 | 710 | 1,700 | 23 | 113 | 170 | 8,800 | 120 | 586 | 880 |
| 3 | 4,110 | 54 | 294 | 294 | 2,175 | 29 | 155 | 155 | 6,285 | 83 | 449 | 449 |
| 7 | 5,633 | 47 | 282 | 704 | 4,035 | 34 | 202 | 504 | 9,668 | 81 | 484 | 1,208 |
| 8 | 20,813 | 98 | 372 | 372 | 6,630 | 28 | 118 | 118 | 27,443 | 116 | 490 | 490 |
| 10 | 8,904 | 56 | 223 | 685 | 3574 | 22 | 89 | 275 | 12,478 | 78 | 312 | 960 |
| 14 | 1,650 | 471 | 825 | 1,650 | .... | .. | ... | ... | 1,650 | 471 | 825 | 1,650 |
| 15 | 47,731 | 95 | 281 | 398 | 8,400 | 17 | 49 | 70 | 56,131 | 112 | 330 | 468 |
| 17 | 9,113 | 66 | 260 | 260 | 6,412 | 46 | 183 | 183 | 15,525 | 112 | 443 | 443 |
| Totals | 105,054 | ... | ... | ... | 32,926 | ... | ... | ... | 137,980 | | | |
| Averages | ..... | 80 | 298 | 409 | .... | 25 | 94 | 128 | ..... | 105 | 392 | 537 |
| **Flat Land** | | | | | | | | | | | | |
| 2 | 30,700 | 192 | 192 | 384 | 4,965 | 31 | 31 | 62 | 35,665 | 223 | 223 | 446 |
| 4 | 3,635 | 91 | 104 | 727 | 625 | 16 | 18 | 125 | 4,260 | 107 | 122 | 852 |
| 5 | 21,065 | 114 | 176 | 211 | 4,600 | 25 | 38 | 46 | 25,665 | 139 | 214 | 257 |
| 6 | 17,150 | 143 | 143 | 181 | 2,630 | 22 | 22 | 28 | 19,780 | 165 | 165 | 209 |
| 9 | 42,657 | 449 | 449 | 1,333 | 3,750 | 39 | 39 | 117 | 46,407 | 488 | 488 | 1,450 |
| 11 | 43,105 | 144 | 276 | 567 | 12,145 | 40 | 78 | 160 | 55,250 | 184 | 354 | 727 |
| 12 | 47,460 | 186 | 475 | 633 | 8,540 | 33 | 85 | 114 | 56,000 | 219 | 560 | 747 |
| 18 | 3,300 | 471 | 660 | 1,320 | .... | .. | .. | ... | 3,300 | 471 | 660 | 1,320 |
| Totals | 209,072 | ... | ... | ... | 37,255 | .. | .. | ... | 246,327 | | | |
| Averages | ..... | 180 | 264 | 449 | .... | 32 | 47 | 80 | ..... | 212 | 311 | 529 |
| **Peat Land** | | | | | | | | | | | | |
| 13 | 12,325 | 308 | 440 | 440 | 1,950 | 49 | 70 | 70 | 14,275 | 357 | 510 | 510 |
| 16 | 4,170 | 208 | 278 | 278 | .... | .. | .. | ... | 4,170 | 208 | 278 | 278 |
| Totals | 16,495 | ... | ... | ... | 1,950 | .. | .. | ... | 18,445 | | | |
| Averages | ..... | 275 | 384 | 384 | .... | 32 | 45 | 45 | ..... | 307 | 429 | 429 |
| Grand totals | 330,621 | ... | ... | ... | 72,131 | .. | .. | ... | 402,752 | | | |
| Grand averages | ..... | 131 | 279 | 432 | .... | 29 | 61 | 94 | ..... | 160 | 340 | 526 |

## TABLE IX

WEIGHT OF TILE ON EACH PROJECT AND ON ALL PROJECTS, TONS

| Farm project No. | 6-inch and less | | | | Over 6-inch | | | | Grand total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Per acre | | | Total | Per acre | | | Total | Per acre | | |
| | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed |
| **Rolling Land** | | | | | | | | | | | | |
| 1 | 25.90 | 0.35 | 1.73 | 2.59 | 11.40 | 0.16 | 0.76 | 1.14 | 37.30 | 0.51 | 2.49 | 3.73 |
| 3 | 14.50 | 0.19 | 1.03 | 1.03 | 16.31 | 0.22 | 1.17 | 1.17 | 30.81 | 0.41 | 2.20 | 2.20 |
| 7 | 22.65 | 0.19 | 1.13 | 2.83 | 40.01 | 0.33 | 2.00 | 5.00 | 62.66 | 0.52 | 3.13 | 7.83 |
| 8 | 75.93 | 0.32 | 1.36 | 1.36 | 115.94 | 0.49 | 2.07 | 2.07 | 191.87 | 0.81 | 3.43 | 3.43 |
| 10 | 38.93 | 0.24 | 0.96 | 2.99 | 42.73 | 0.27 | 1.08 | 3.29 | 81.66 | 0.51 | 2.04 | 6.28 |
| 14 | 7.43 | 2.12 | 3.72 | 7.43 | ..... | ... | ... | ... | 7.43 | 2.12 | 3.72 | 7.43 |
| 15 | 198.47 | 0.40 | 1.17 | 1.65 | 109.43 | 0.22 | 0.64 | 0.91 | 307.90 | 0.62 | 1.81 | 2.56 |
| 17 | 51.00 | 0.37 | 1.46 | 1.46 | 141.00 | 1.01 | 4.03 | 4.03 | 192.00 | 1.38 | 5.49 | 5.49 |
| Totals | 434.81 | ... | ... | ... | 476.82 | ... | ... | ... | 911.63 | | | |
| Averages | ..... | 0.33 | 1.24 | 1.69 | ..... | 0 36 | 1.35 | 1.85 | ..... | 0.69 | 2.59 | 3.54 |
| **Flat Land** | | | | | | | | | | | | |
| 2 | 98.55 | 0.62 | 0.62 | 1.24 | 152.61 | 0.95 | 0.95 | 1.90 | 251.16 | 1.57 | 1.57 | 3.14 |
| 4 | 13.32 | 0.33 | 0 38 | 2.66 | 4.01 | 0.10 | 0.11 | 0.80 | 17.33 | 0.43 | 0.49 | 3.46 |
| 5 | 81.94 | 0.44 | 0.68 | 0.82 | 139.00 | 0.76 | 1.16 | 1.40 | 220.94 | 1.20 | 1.84 | 2.22 |
| 6 | 59.17 | 0.49 | 0.49 | 0.62 | 26.10 | 0.22 | 0.22 | 0.28 | 85.27 | 0.71 | 0.71 | 0.90 |
| 9 | 151.43 | 1.60 | 1.60 | 4.73 | 58.25 | 0.61 | 0.61 | 1.82 | 209.68 | 2.21 | 2.21 | 6.55 |
| 11 | 226.20 | 0.75 | 1.45 | 2.98 | 224.10 | 0.75 | 1.44 | 2.95 | 450.30 | 1.50 | 2.89 | 5.93 |
| 12 | 243.30 | 0.95 | 2.43 | 3.24 | 299.59 | 1.18 | 3.00 | 4.00 | 542.89 | 2.13 | 5.43 | 7.24 |
| 18 | 15.68 | 2.24 | 3.14 | 1.57 | ..... | ... | ... | ... | 15.68 | 2.24 | 3.14 | 1.57 |
| Totals | 889.59 | ... | ... | ... | 903.66 | ... | ... | ... | 1,793.25 | | | |
| Averages | ..... | 0.77 | 1.13 | 1.91 | ..... | 0.78 | 1.14 | 1.94 | ..... | 1.55 | 2.27 | 3.85 |
| **Peat Land** | | | | | | | | | | | | |
| 13 | 57.23 | 1.43 | 2.04 | 2.04 | 15.70 | 0.39 | 0.56 | 0.56 | 72.93 | 1.82 | 2.60 | 2.60 |
| 16 | 18.77 | 0.94 | 1.25 | 1.25 | ..... | ... | ... | ... | 18.77 | 0.94 | 1.25 | 1.25 |
| Totals | 76.00 | ... | ... | ... | 15.70 | ... | ... | ... | 91.70 | | | |
| Averages | ..... | 1.27 | 1.77 | 1.77 | ..... | 0.26 | 0.37 | 0.37 | ..... | 1.53 | 2.14 | 2.14 |
| Grand totals | 1,400.40 | ... | ... | ... | 1,396.18 | ... | ... | ... | 2,796.58 | | | |
| Grand averages | ..... | 0.55 | 1.18 | 1.83 | ..... | 0.55 | 1.18 | 1.83 | ..... | 1.10 | 2.36 | 3.65 |

## TABLE X

WEIGHT OF TILE ON EACH PROJECT AND ON ALL PROJECTS, IN CARLOADS (30,000 LBS.)

| Farm project No. | 6-inch and less | | | | Over 6-inch | | | | Grand total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Per acre | | | Total | Per acre | | | Total | Per acre | | |
| | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed | | Of watershed on farm | Drained | Reclaimed |
| **Rolling Land** | | | | | | | | | | | | |
| 1 | 1.73 | 0.02 | 0.12 | 0.17 | 0.76 | 0.01 | 0.05 | 0.08 | 2.49 | 0.03 | 0.17 | 0.25 |
| 3 | 0.96 | 0.01 | 0.07 | 0.07 | 1.09 | 0.02 | 0.08 | 0.08 | 2.05 | 0.03 | 0.15 | 0.15 |
| 7 | 1.51 | 0.01 | 0.08 | 0.19 | 2.67 | 0.02 | 0.13 | 0.33 | 4.18 | 0.03 | 0.21 | 0.52 |
| 8 | 5.06 | 0.02 | 0.09 | 0.09 | 7.73 | 0.03 | 0.14 | 0.14 | 12.79 | 0.05 | 0.23 | 0.23 |
| 10 | 2.64 | 0.02 | 0.07 | 0.20 | 2.85 | 0.02 | 0.07 | 0.22 | 5.49 | 0.04 | 0.14 | 0.42 |
| 14 | 0.50 | 0.14 | 0.25 | 0.50 | .... | ... | ... | ... | 0.50 | 0.14 | 0.25 | 0.50 |
| 15 | 3.23 | 0.03 | 0.08 | 0.11 | 7.30 | 0 01 | 0.04 | 0 06 | 20.53 | 0 04 | 0.12 | 0.17 |
| 17 | 3.40 | 0.02 | 0.10 | 0.10 | 9.40 | 0.07 | 0.27 | 0.27 | 12.80 | 0.09 | 0.37 | 0.37 |
| Totals | 29.03 | ... | ... | ... | 31.80 | ... | ... | ... | 60.83 | | | |
| Averages | .... | 0.02 | 0.08 | 0.11 | .... | 0.02 | 0.09 | 0.12 | ..... | 0.04 | 0.17 | 0.23 |
| **Flat Land** | | | | | | | | | | | | |
| 2 | 6.57 | 0.04 | 0.04 | 0.08 | 10.17 | 0.06 | 0.06 | 0.13 | 16.74 | 0.10 | 0.10 | 0.21 |
| 4 | 0.89 | 0.02 | 0.02 | 0.18 | 0.27 | 0.01 | 0.01 | 0.05 | 1.16 | 0.03 | 0.03 | 0.23 |
| 5 | 5.46 | 0.03 | 0.05 | 0.05 | 9.27 | 0 05 | 0.08 | 0.09 | 14.73 | 0.08 | 0.12 | 0.15 |
| 6 | 3.95 | 0.03 | 0.03 | 0.04 | 1.74 | 0.02 | 0.02 | 0.02 | 5.69 | 0.05 | 0.05 | 0.06 |
| 9 | 10.10 | 0.11 | 0.11 | 0.32 | 3.88 | 0.04 | 0.04 | 0.12 | 13.98 | 0.15 | 0.15 | 0.44 |
| 11 | 15.08 | 0 05 | 0.10 | 0.20 | 14.92 | 0 05 | 0.10 | 0.20 | 30.00 | 0.10 | 0.19 | 0.40 |
| 12 | 16.21 | 0.06 | 0.16 | 0.22 | 19.98 | 0.08 | 0.20 | 0.26 | 36.19 | 0.14 | 0.36 | 0.48 |
| 18 | 1.05 | 0.15 | 0.21 | 0.42 | .... | ... | ... | ... | 1.05 | 0.15 | 0.21 | 0.42 |
| Totals | 59.31 | ... | ... | ... | 60.23 | ... | ... | ... | 119.54 | | | |
| Averages | .... | 0.05 | 0.07 | 0.13 | .... | 0.05 | 0.08 | 0.13 | .... | 0.10 | 0.15 | 0.26 |
| **Peat Land** | | | | | | | | | | | | |
| 13 | 3.81 | 0.09 | 0.14 | 0.14 | 0.14 | 0.03 | 0.04 | 0.04 | 4.86 | 0.12 | 0.18 | 0.18 |
| 16 | 1.25 | 0.06 | 0.08 | 0.08 | .... | ... | ... | ... | 1.25 | 0.06 | 0.08 | 0.08 |
| Totals | 5.06 | ... | ... | ... | 1.05 | ... | ... | ... | 6.11 | | | |
| Averages | .... | 0.08 | 0.12 | 0.12 | .... | 0.02 | 0.02 | 0.02 | .... | 0.10 | 0.14 | 0.14 |
| Grand totals | 93.40 | ... | ... | ... | 93.08 | ... | ... | ... | 186.48 | | | |
| Grand averages | .... | 0.04 | 0.09 | 0.12 | .... | 0.04 | 0.08 | 0.12 | .... | 0.08 | 0.17 | 0.24 |

TABLE XI

ACTUAL MONEY COST OF TILE PER ACRE; AND PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Total cost | Per acre | | | Per | | |
|---|---|---|---|---|---|---|---|
| | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | |
| 1 | $ 171.65 | $ 2.35 | $11.44 | $17.17 | $19.51 | $4.60 | $ 68.94 |
| 3 | 166.97 | 2.20 | 11.93 | 11.93 | 26.59 | 5.42 | 81.45 |
| 7 | 407.03 | 3.39 | 20.35 | 50.88 | 42.10 | 6.50 | 97.45 |
| 8 | 1,198.45 | 5.06 | 21.40 | 21.40 | 43.67 | 6.25 | 93.69 |
| 10 | 278.10 | 1.74 | 6.95 | 21.39 | 22.29 | 3.41 | 50.65 |
| 14 | 54.12 | 15.46 | 27.06 | 54.12 | 32.80 | 7.29 | 109.33 |
| 15 | 2,589.36 | 5.18 | 15.23 | 21.58 | 46.13 | 8.41 | 126.13 |
| 17 | 1,278.11 | 9.20 | 36.52 | 36.52 | 82.33 | 6.66 | 99.99 |
| Totals | $6,143.79 | .... | .... | .... | .... | .... | .... |
| Averages | ..... | $ 4.70 | $17.45 | $23.91 | $44.53 | $6.74 | $101.00 |
| **Flat Land** | | | | | | | |
| 2 | $ 1,833 19 | $11.46 | $11.46 | $22.92 | $51.40 | $7.30 | $109.48 |
| 4 | 86.91 | 2.17 | 2.48 | 17.38 | 20.40 | 5.02 | 75.25 |
| 5 | 1,589.13 | 8.59 | 13.24 | 15.89 | 61.92 | 7.19 | 107.88 |
| 6 | 406.17 | 3.38 | 3.38 | 4.28 | 20.53 | 4.76 | 71.43 |
| 9 | 1,211.25 | 12.75 | 12.75 | 37.85 | 26.10 | 5.78 | 86.65 |
| 11 | 3,126.58 | 10.42 | 20.04 | 41.14 | 56.59 | 6.94 | 104.22 |
| 12 | 4,138.24 | 16.23 | 41.38 | 55.18 | 73.90 | 7.62 | 114.35 |
| 18 | 68.38 | 9.77 | 13.68 | 27.35 | 20.72 | 4.36 | 65.44 |
| Totals | $12,459.85 | .... | .... | .... | .... | .... | .... |
| Averages | ..... | $10.72 | $15.75 | $26.77 | $50.58 | $6.95 | $104.23 |
| **Peat Land** | | | | | | | |
| 13 | $ 498.41 | $12.46 | $17.80 | $17.80 | $34.91 | $6.83 | $102.55 |
| 16 | 136.78 | 6.84 | 9.12 | 9.12 | 32.80 | 7.29 | 109.34 |
| Totals | $ 635.19 | .... | .... | .... | .... | .... | .... |
| Averages | ..... | $10.59 | $14.77 | $14.77 | $34.44 | $6.93 | $103.96 |
| Grand totals | $19,238.83 | .... | .... | .... | .... | .... | .... |
| Grand averages | ..... | $ 7.60 | $16.22 | $25.13 | $47.77 | $6.46 | $103.17 |

TABLE XII

CARLOADS AND TONS OF TILE, MILES OF RAILROAD AND OF TEAM OR TRUCK HAUL, CARLOAD MILES OF RAILROAD HAUL, AND TON MILES OF TEAM OR TRUCK HAUL

| Farm project No. | Total carloads of tile | Total miles of railroad haul | Total carload miles of railroad haul | Total tons of tile | Total miles of team or truck haul | Total ton miles of team or truck haul |
|---|---|---|---|---|---|---|
| **Rolling Land** | | | | | | |
| 1 | 2.49 | 140 | 348.60 | 37.30 | 0.50 | 18.65 |
| 3 | 2.05 | 145 | 297.25 | 30.81 | 5.00 | 154.05 |
| 7 | 4.18 | 295 | 1,233.10 | 62.66 | 1.50 | 93.99 |
| 8 | 12.79 | 105 | 1,342.95 | 191.87 | 3.00 | 575.61 |
| 10 | 5.49 | 517 | 2,838.33 | 81.66 | 7.00 | 571.62 |
| 14 | 0.50 | ... | ..... | 7.43 | 13.00 | 96.59 |
| 15 | 20.53 | 143 | 2,953.79 | 307.90 | 3.50 | 1,077.65 |
| 17 | 12.80 | 88 | 1,126.40 | 192.00 | 5.00 | 960.00 |
| Totals | 60.83 | 1,433 | 10,122.42 | 911.63 | 38.50 | 3,548.16 |
| **Flat Land** | | | | | | |
| 2 | 16.74 | 431 | 7,214.94 | 251.16 | 2.50 | 627.90 |
| 4 | 1.16 | 150 | 174.00 | 17.33 | 2.00 | 34.66 |
| 5 | 14.73 | 348 | 5,126.04 | 220.94 | 2.00 | 441.88 |
| 6 | 5.69 | 10 | 56.90 | 85.27 | 8.00 | 682.16 |
| 9 | 13.98 | 398 | 5,564.04 | 209.68 | 0.50 | 104.84 |
| 11 | 30.00 | 44 | 1,320.00 | 450.30 | 1.00 | 450.30 |
| 12 | 36.19 | 44 | 1,592.36 | 542.89 | 2.50 | 1,357.23 |
| 18 | 1.05 | 336 | 352.80 | 15.68 | 1.00 | 15.68 |
| Totals | 119.54 | 1,761 | 21,401.08 | 1,793.25 | 19.50 | 3,714.65 |
| **Peat Land** | | | | | | |
| 13 | 4.86 | 110 | 534.60 | 72.93 | 4.25 | 309.95 |
| 10 | 1.25 | 201 | 251.25 | 18.77 | 0.25 | 4.69 |
| Totals | 6.11 | 311 | 785.85 | 91.70 | 4.50 | 314.64 |
| Grand totals | 186.48 | 3,505 | 32,309.35 | 2,976.58 | 62.50 | 7,577.45 |

TABLE XIII

ACTUAL MONEY COST OF FREIGHT ON TILE PER ACRE, PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE; AND PER CARLOAD MILE OF RAILROAD HAUL

| Farm project No. | Total cost | Per acre | | | Per | | | |
|---|---|---|---|---|---|---|---|---|
| | | Of watershed on farm | Drained | Reclaimed | 1000 linear feet of tile | Ton of tile | Carload of tile | Carload mile of railroad haul |
| **Rolling Land** | | | | | | | | |
| 1..... | $ 55.97 | $0.77 | $3.73 | $ 5.60 | $ 6.36 | $1.50 | $22.48 | $0.16 |
| 3..... | 37.02 | 0.49 | 2.64 | 2.64 | 5.89 | 1.20 | 18.06 | 0.12 |
| 7..... | 150.39 | 1.25 | 7.52 | 18.80 | 15.56 | 2.40 | 25.23 | 0.12 |
| 8..... | 277.51 | 1.17 | 4.96 | 4.96 | 10.11 | 1.45 | 21.70 | 0.21 |
| 10..... | 301.79 | 2.14 | 8.57 | 26.37 | 27.47 | 4.20 | 62.42 | 0.11 |
| 14..... | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 15..... | 369.48 | 0.74 | 2.17 | 3.08 | 6.58 | 1.20 | 18.00 | 0.13 |
| 17..... | 294.29 | 2.12 | 8.41 | 8.41 | 18.96 | 1.52 | 22.99 | 0.26 |
| Totals ..... | $1,527.42 | | | | | | | |
| Averages... | ..... | $1.17 | $4.34 | $ 5.94 | $11.07 | $1.68 | $25.11 | $0.15 |
| **Flat Land** | | | | | | | | |
| 2..... | $867.68 | $ 5.42 | $ 5.42 | $10.85 | $24.33 | $3.45 | $51.82 | $0.12 |
| 4..... | 20.79 | 0.52 | 0.59 | 4.16 | 4.88 | 1.20 | 18.00 | 0.12 |
| 5..... | 572.69 | 3.10 | 4.77 | 5 73 | 22.31 | 2.59 | 38.88 | 0.11 |
| 6..... | 46.03 | 0.38 | 0.38 | 0.49 | 2.33 | 0.54 | 8.10 | 0.08 |
| 9..... | 587.16 | 6.18 | 6.18 | 18.35 | 12.65 | 2.80 | 42.00 | 0.11 |
| 11..... | 320.65 | 1.07 | 2.06 | 4.22 | 5.80 | 0.71 | 10.69 | 0.24 |
| 12..... | 386.74 | 1.52 | 3.87 | 5.16 | 6.91 | 0.71 | 10.69 | 0.24 |
| 18..... | 72.62 | 10.37 | 14.52 | 29.05 | 22.01 | 4.63 | 69.49 | 0.21 |
| Totals ..... | $2,874.36 | | | | | | | |
| Averages... | ..... | $ 2.47 | $ 3.63 | $ 6.17 | $11.67 | $1.60 | $24.05 | $0.13 |
| **Peat Land** | | | | | | | | |
| 13..... | $164.86 | $4.12 | $5.89 | $5.89 | $11.55 | $2.26 | $33.92 | $0.31 |
| 16..... | 43.16 | 2.16 | 2.88 | 2.88 | 10.35 | 2.30 | 34.50 | 0.17 |
| Totals ..... | $208.02 | | | | | | | |
| Averages... | ..... | $3.47 | $4.84 | $4.84 | $11.28 | $2.27 | $34.05 | $0.26 |
| Grand totals | $4,568.83 | | | | | | | |
| Grand averages..... | ..... | $1.81 | $3.85 | $5.97 | $11.34 | $1.53 | $24.50 | $0.14 |

TABLE XIV

COST IN MONEY AND IN TIME OF HAUL AND DISTRIBUTION OF TILE PER MAN HOUR, PER ACRE, AND PER 1000 LINEAR FEET, PER TON AND PER CARLOAD OF TILE, AND PER TON MILE OF TEAM OR TRUCK HAUL

| Farm project No. | Cost in dollars: Total cost | Per man hour | Per acre: Of watershed on farm | Per acre: Drained | Per acre: Reclaimed | Per: 1000 lin. ft. of tile | Per: Ton of tile | Per: Carload of tile | Per: Ton mile of team or truck haul |
|---|---|---|---|---|---|---|---|---|---|
| **Rolling Land** | | | | | | | | | |
| 1..... | $ 24.48 | $0.19 | $0.34 | $ 1.63 | $ 2.45 | $ 2.72 | $0.66 | $ 9.83 | $1.31 |
| 3..... | 68.28 | 0.18 | 0.90 | 4.88 | 4.88 | 10.86 | 2.22 | 33.31 | 0.44 |
| 7..... | 66.88 | 0.20 | 0.56 | 3.34 | 8.36 | 6.92 | 1.07 | 16.01 | 0.71 |
| 8..... | 198.00 | 0.25 | 0.84 | 3.54 | 3.54 | 7.22 | 1.03 | 15.48 | 0.34 |
| 10..... | 133.10 | 0.20 | 0.83 | 3.30 | 10.24 | 10.67 | 1.63 | 24.24 | 0.23 |
| 14..... | 30.00 | 0.50 | 8.57 | 15.00 | 30.00 | 18.18 | 4.04 | 60.60 | 0.31 |
| 15..... | 500.30 | 0.32 | 1.00 | 2.94 | 4.17 | 8.91 | 1.62 | 24.37 | 0.46 |
| 17..... | 330.64 | 0.30 | 2.38 | 9.45 | 9.45 | 21.30 | 1.72 | 25.83 | 0.34 |
| Totals..... | $1,351.68 | .... | .... | .... | .... | .... | .... | .... | .... |
| Averages... | ..... | $0.27 | $1.03 | $ 3.84 | $ 5.26 | $ 9.80 | $1.48 | $22.22 | $0.38 |
| **Flat Land** | | | | | | | | | |
| 2..... | $ 371.87 | $0.29 | $2.32 | $2.32 | $ 4.65 | $10.43 | $1.48 | $22.21 | $0.59 |
| 4..... | 10.13 | 0.23 | 0.25 | 0.29 | 2.03 | 0.95 | 0.58 | 0.88 | 0.23 |
| 5..... | 180.52 | 0.23 | 0.98 | 1.50 | 1.81 | 3.52 | 0.41 | 6.13 | 0.20 |
| 6..... | 182.00 | 0.18 | 1.52 | 1.52 | 1.92 | 9.20 | 2.26 | 33.90 | 0.28 |
| 9..... | 118.25 | 0.59 | 1.24 | 1.24 | 3.70 | 2.55 | 0.56 | 8.46 | 1.13 |
| 11..... | 292.72 | 0.35 | 0.98 | 1.88 | 3.85 | 5.30 | 0.65 | 9.76 | 0.65 |
| 12..... | 899.22 | 0.33 | 3.53 | 8.99 | 11.99 | 16.06 | 1.66 | 24.85 | 0.66 |
| 18..... | 10.20 | 0.41 | 1.46 | 2.04 | 4.08 | 3.09 | 0.65 | 9.76 | 0.65 |
| Totals..... | $2,064.91 | .... | .... | .... | .... | .... | .... | .... | .... |
| Averages... | ..... | $0.35 | $1.78 | $2.61 | $ 4.44 | $ 8.38 | $1.15 | $17.28 | $0.56 |
| **Peat Land** | | | | | | | | | |
| 13..... | $ 122.40 | $0.29 | $3.06 | $4.37 | $4.37 | $8.57 | $1.68 | $25.19 | $0.39 |
| 16..... | 18.00 | 0.45 | 0.90 | 1.20 | 1.20 | 4.32 | 0.96 | 14.38 | 3.84 |
| Totals..... | $ 140.40 | .... | .... | .... | .... | .... | .... | .... | .... |
| Averages... | ..... | $0.31 | $2.34 | $3.27 | $3.27 | $7.61 | $1.53 | $22.98 | $0.45 |
| Grand totals. | $3,556.99 | .... | .... | .... | .... | .... | .... | .... | .... |
| Grand averages ..... | ..... | $0.31 | $1.41 | $3.00 | $4.65 | $8.83 | $1.19 | $19.07 | $0.47 |

TABLE XIV—*Continued*

COST IN MONEY AND IN TIME OF HAUL AND DISTRIBUTION OF TILE PER MAN HOUR, PER ACRE, AND PER 1000 LINEAR FEET, PER TON AND PER CARLOAD OF TILE, AND PER TON MILE OF TEAM OR TRUCK HAUL

| Farm project No. | Time in hours: Total man hours | Per acre: Of watershed on farm | Per acre: Drained | Per acre: Reclaimed | Per: 1000 lin. ft. of tile | Per: Ton of tile | Per: Carload of tile | Per: Ton mile of team or truck haul |
|---|---|---|---|---|---|---|---|---|
| **Rolling Land** | | | | | | | | |
| 1..... | 130 | 1.78 | 8.67 | 13.00 | 14.77 | 3.49 | 52.21 | 6.97 |
| 3..... | 380 | 5.00 | 27.14 | 27.14 | 60.46 | 12.33 | 185.37 | 2.46 |
| 7..... | 340 | 2.83 | 17.00 | 42.50 | 35.17 | 5.43 | 81.34 | 3.62 |
| 8..... | 790 | 3.33 | 14.11 | 14.11 | 28.79 | 4.12 | 61.77 | 1.37 |
| 10..... | 670 | 4.19 | 16.75 | 51.54 | 53.69 | 8.20 | 122.04 | 1.17 |
| 14..... | 60 | 17.14 | 30.00 | 60.00 | 36.36 | 8.08 | 120.00 | 0.62 |
| 15..... | 1,540 | 3.08 | 9.06 | 12.83 | 27.44 | 5.00 | 75.01 | 1.43 |
| 17..... | 1,100 | 7.91 | 31.43 | 31.43 | 70.85 | 5.73 | 85.94 | 1.15 |
| Totals..... | 5,010 | .... | .... | .... | .... | .... | .... | ... |
| Averages.... | ..... | 3.83 | 14.23 | 19.49 | 36.31 | 5.50 | 82.36 | 1.41 |
| **Flat Land** | | | | | | | | |
| 2..... | 1,300 | 8.12 | 8.12 | 16.25 | 36.45 | 5.18 | 77.66 | 2.07 |
| 4..... | 45 | 1.12 | 1.29 | 9.00 | 10.56 | 2.60 | 38.79 | 1.30 |
| 5..... | 780 | 4.22 | 6.50 | 7.80 | 30.39 | 3.53 | 52.95 | 1.77 |
| 6..... | 1,040 | 8.67 | 8.67 | 10.94 | 52.58 | 12.20 | 182.77 | 1.52 |
| 9..... | 200 | 2.10 | 2.10 | 6.25 | 4.31 | 0.95 | 14.31 | 1.91 |
| 11..... | 840 | 2.80 | 5.38 | 11.05 | 15.20 | 1.87 | 28.00 | 1.87 |
| 12..... | 2,730 | 10.70 | 27.30 | 36.40 | 48.75 | 5.03 | 75.44 | 2.01 |
| 18..... | 25 | 3.57 | 5.00 | 10.00 | 7.57 | 1.59 | 23.81 | 1.59 |
| Totals..... | 5,960 | .... | .... | .... | .... | .... | .... | ... |
| Averages.... | ..... | 5.13 | 7.53 | 12.80 | 24.20 | 3.32 | 49.86 | 1.60 |
| **Peat Land** | | | | | | | | |
| 13..... | 420 | 10.50 | 15.00 | 15.00 | 29.42 | 5.76 | 86.42 | 1.36 |
| 16..... | 40 | 2.00 | 2.67 | 2.67 | 9.59 | 2.13 | 32.00 | 8.53 |
| Totals..... | 460 | .... | .... | .... | .... | .... | .... | ... |
| Averages.... | ..... | 7.67 | 10.70 | 10.70 | 24.94 | 5.02 | 75.29 | 1.46 |
| Grand totals.. | 11,430 | .... | .... | .... | .... | .... | .... | ... |
| Grand averages ..... | ..... | 4.52 | 9.64 | 14.93 | 28.38 | 3.84 | 61.29 | 1.51 |

## TABLE XV

COST IN MONEY AND IN TIME OF TRENCHING, LAYING, AND BLINDING PER MAN HOUR, PER ACRE, PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Cost in dollars | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Per hour | Per acre | | | Per | | |
| | | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | | |
| 1 | $ 256.00 | $0.20 | $3.51 | $17.07 | $25.60 | $29.09 | $6.86 | $102.81 |
| 3 | 316.50 | 0.35 | 4.16 | 22.61 | 22.61 | 50.36 | 10.27 | 154.39 |
| 7 | 415.97 | 0.27 | 3.47 | 20.80 | 52.00 | 43.03 | 6.64 | 99.59 |
| 8 | 1,424.09 | 0.36 | 6.01 | 25.43 | 25.43 | 51.89 | 7.42 | 111.34 |
| 10 | 1,515.76 | 0.49 | 9.47 | 37.89 | 116.60 | 121.48 | 18.56 | 276.04 |
| 14 | 90.00 | 0.90 | 25.71 | 45.00 | 90.00 | 54.54 | 12.12 | 181.82 |
| 15 | 4,296.63 | 0.79 | 8.59 | 25.27 | 35.81 | 76.55 | 13.95 | 209.29 |
| 17 | 1,561.23 | 0.66 | 11.23 | 44.61 | 44.61 | 100.56 | 8.13 | 121.97 |
| Totals | $9,876.18 | .... | .... | .... | .... | .... | .... | ..... |
| Averages | ..... | $0.53 | $7.55 | $28.06 | $38.43 | $71.58 | $10.83 | $162.36 |
| **Flat Land** | | | | | | | | |
| 2 | $1,378.34 | $0.17 | $8.62 | $8.62 | $17.23 | $38.65 | $5.49 | $82.31 |
| 4 | 221.35 | 0.41 | 5.53 | 6.32 | 44.27 | 5.20 | 12.77 | 19.16 |
| 5 | 1,115.00 | 0.33 | 6.03 | 9.29 | 11.15 | 43.44 | 5.05 | 75.70 |
| 6 | 670.37 | 0.33 | 5.59 | 5.59 | 7.06 | 33.89 | 7.86 | 117.90 |
| 9 | 2,142.30 | 0.26 | 22.55 | 22.55 | 66.95 | 46.16 | 10.22 | 153.25 |
| 11 | 2,806.29 | 0.28 | 9.35 | 17.99 | 36.92 | 50.79 | 6.23 | 93.54 |
| 12 | 3,656.48 | 0.38 | 14.34 | 36.56 | 48.75 | 65.29 | 6.74 | 101.04 |
| 18 | 80.50 | 0.35 | 11.50 | 16.10 | 32.20 | 24.39 | 5.13 | 77.03 |
| Totals | $12,070.63 | .... | .... | .... | .... | .... | .... | ..... |
| Averages | ..... | $0.29 | $10.39 | $15.26 | $25.93 | $49.00 | $6.73 | $100.98 |
| **Peat Land** | | | | | | | | |
| 13 | $1,110.08 | $0.86 | $27.75 | $39.65 | $39.65 | $77.76 | $15.22 | $228.41 |
| 16 | 376.00 | 0.77 | 18.80 | 25.07 | 25.07 | 9.02 | 20.04 | 300.56 |
| Totals | $1,486.08 | .... | .... | .... | .... | .... | .... | ..... |
| Averages | ..... | $0.84 | $24.77 | $34.56 | $34.56 | $80.57 | $16.21 | $243.22 |
| Grand totals | $23,432.89 | .... | .... | .... | .... | .... | .... | ..... |
| Grand averages | ..... | $0.37 | $9.26 | $19.76 | $30.61 | $58.18 | $7.87 | $125.66 |

TABLE XV—*Continued*

COST IN MONEY AND IN TIME OF TRENCHING, LAYING, AND BLINDING PER MAN HOUR, PER ACRE, PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Time in hours | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total | Per acre | | | Per | | |
| | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | |
| 1 | 1,300 | 17.81 | 86.67 | 130.00 | 147.73 | 34.85 | 522.09 |
| 3 | 910 | 11.97 | 65 00 | 65.00 | 144.79 | 29.53 | 443.90 |
| 7 | 1,555 | 12.96 | 77.75 | 194.38 | 160.84 | 24.82 | 372.01 |
| 8 | 4,010 | 16.92 | 71.61 | 71.61 | 146.12 | 20.89 | 313 53 |
| 10 | 3,072 | 19.20 | 76.80 | 236.31 | 246.19 | 37.62 | 559.56 |
| 14 | 100 | 28.57 | 50.00 | 100.00 | 60.60 | 13.46 | 200.00 |
| 15 | 5,420 | 10.84 | 31.88 | 45.17 | 96.56 | 17.60 | 264.00 |
| 17 | 2,360 | 16.98 | 67.43 | 67.43 | 152.01 | 12.29 | 184.38 |
| Totals | 18,727 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 14.31 | 53.20 | 72.87 | 135.72 | 20.54 | 307.86 |
| **Flat Land** | | | | | | | |
| 2 | 8,270 | 51.69 | 51.69 | 103 37 | 231.88 | 32.93 | 494.03 |
| 4 | 540 | 13.50 | 15.43 | 108.00 | 126.76 | 31.16 | 465.52 |
| 5 | 3,330 | 18.00 | 27.75 | 33.30 | 129.75 | 15 07 | 226.07 |
| 6 | 2,030 | 16.92 | 16.92 | 21.37 | 102.63 | 23.81 | 356.77 |
| 9 | 8,180 | 86.11 | 86.11 | 255.62 | 176.27 | 39.01 | 585.12 |
| 11 | 9,880 | 32.93 | 63.33 | 130.00 | 178.82 | 21.94 | 329.33 |
| 12 | 9,720 | 38.12 | 97.20 | 129.60 | 173.57 | 17.90 | 268.58 |
| 18 | 230 | 32.86 | 46.00 | 92.00 | 69.70 | 14.67 | 219.05 |
| Totals | 42,180 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 36.30 | 53.32 | 90.61 | 171.24 | 23.52 | 352.85 |
| **Peat Land** | | | | | | | |
| 13 | 1,288 | 32.20 | 46.00 | 46.00 | 90.23 | 17.66 | 265.02 |
| 16 | 488 | 24.40 | 32.53 | 32.53 | 117.03 | 26.00 | 390.40 |
| Totals | 1,776 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 29.60 | 41.30 | 41.30 | 96.29 | 19.37 | 290.67 |
| Grand totals | 62,683 | .... | .... | .... | ..... | .... | ..... |
| Grand averages | .... | 24.77 | 52.85 | 81.89 | 155.64 | 21.06 | 336.14 |

TABLE XVI

WORK UNITS, MAN HOURS, SIZE OF TILE, AND AVERAGE CUT FOR EACH PROJECT AND FOR ALL PROJECTS IN EASY DIGGING

| Farm project No. | Tile | | | Work units | | | Total man hours labor |
|---|---|---|---|---|---|---|---|
| | Inner diameter, inches | Average cut, feet | Total linear feet | Per linear foot | Total per item | Grand total per project | |
| 13 | 6 or under | 3.56 | 12,325 | 6.2 | 76,415.0 | | |
| | 7 | 4.80 | 700 | 13.5 | 9,450.0 | | |
| | 8 | 4.20 | 1,250 | 11.8 | 14,750.0 | 100,615.0 | 1,288 |
| 16 | 5 | 3.41 | 4,170 | 5.7 | 23,769.0 | 23,769.0 | 488 |
| Totals—easy digging | | | | | | 124,384.0 | 1,776 |
| Work units per man hour—easy digging | | | | | | 70.0 | |

## TABLE XVII

WORK UNITS, MAN HOURS, SIZE OF TILE, AND AVERAGE CUT FOR EACH PROJECT AND FOR ALL PROJECTS IN AVERAGE DIGGING

| Farm project No. | Tile | | | Work units | | | Total man hours labor |
|---|---|---|---|---|---|---|---|
| | Inner diameter, inches | Average cut, feet | Total linear feet | Per linear foot | Total per item | Grand total per project | |
| 1..... | 6 or under | 3.34 | 7,100 | 5.5 | 39,050.0 | | |
| | 7 | 3.77 | 900 | 8.2 | 7,380.0 | | |
| | 8 | 4.06 | 800 | 11.0 | 8,800.0 | 55,230.0 | 1,300 |
| 2..... | 6 or under | 2.80 | 30,700 | 4.4 | 135,080.0 | | |
| | 15 | 6.50 | 1,000 | 51.7 | 51,700.0 | | |
| | 16 | 6.50 | 1,500 | 55.0 | 82,500.0 | | |
| | 18 | 6.50 | 2,465 | 62.3 | 153,569.5 | 422,849.5 | 8,270 |
| 3..... | 6 or under | 3.05 | 4,110 | 4.6 | 18,906.0 | | |
| | 8 | 4.50 | 2,175 | 13.6 | 29,580.0 | 62,460.0 | 910 |
| 4..... | 6 or under | 3.31 | 3,635 | 5.5 | 19,992.5 | | |
| | 7 | 5.05 | 450 | 14.8 | 6,660.0 | | |
| | 8 | 5.05 | 175 | 16.8 | 2,940.0 | 29,592.5 | 540 |
| 5..... | 6 or under | 3.13 | 21,065 | 4.7 | 99,005.5 | | |
| | 16 | 5.20 | 2,100 | 35.8 | 75,180.0 | | |
| | 18 | 5.50 | 2,500 | 44.6 | 111,500.0 | 285,685.5 | 3,330 |
| 6..... | 6 or under | 3.14 | 17,150 | 4.7 | 80,605.0 | | |
| | 8 | 2.70 | 1,355 | 5.7 | 13,423.5 | | |
| | 10 | 3.22 | 1,275 | 8.0 | 10,200.0 | 104,228.5 | 2,030 |
| 8..... | 6 or under | 3.31 | 20,813 | 5.5 | 114,471.5 | | |
| | 7 | 3.55 | 1,190 | 7.1 | 8,449.0 | | |
| | 8 | 3.90 | 800 | 10.0 | 8,000.0 | | |
| | 10 | 4.20 | 300 | 14.2 | 4,260.0 | | |
| | 12 | 4.03 | 2,000 | 15.5 | 31,000.0 | | |
| | 14 | 4.30 | 200 | 21.8 | 4,360.0 | | |
| | 16 | 5.00 | 1,500 | 32.8 | 49,200.0 | | |
| | 18 | 3.20 | 640 | 15.7 | 10,048.0 | 229,788.5 | 4,010 |
| 9..... | 6 or under | 3.29 | 42,657 | 5.5 | 234,613.5 | | |
| | 8 | 3.34 | 1,040 | 7.0 | 7,280.0 | | |
| | 10 | 3.30 | 760 | 8.4 | 6,384.0 | | |
| | 12 | 3.60 | 450 | 12.0 | 5,400.0 | | |
| | 14 | 4.70 | 1,500 | 26.0 | 39,000.0 | 292,677.5 | 8,180 |
| Totals for average digging, carried forward..... | | | | | | 1,468,538.0 | 28,570 |

TABLE XVII—*Continued*

WORK UNITS, MAN HOURS, SIZE OF TILE, AND AVERAGE CUT FOR EACH PROJECT AND FOR ALL PROJECTS IN AVERAGE DIGGING

| Farm project No. | Tile | | | Work units | | | Total man hours labor |
|---|---|---|---|---|---|---|---|
| | Inner diameter, inches | Average cut, feet | Total linear feet | Per linear foot | Total per item | Grand total per project | |
| Totals brought forward | | | | | | 1,468,538.0 | 28,570 |
| 11..... | 6 or under | 3.53 | 43,105 | 6.1 | 262,940.5 | | |
| | 8 | 4.85 | 2,675 | 15.6 | 41,730.0 | | |
| | 10 | 5.39 | 2,900 | 24.2 | 70,180.0 | | |
| | 12 | 5.55 | 6,000 | 30.3 | 181,800.0 | | |
| | 14 | 5.52 | 200 | 35.5 | 7,100.0 | | |
| | 18 | 6.11 | 330 | 55.0 | 18,150.0 | | |
| | 22 | 4.34 | 40 | 35.5 | 1,420.0 | 583,320.5 | 9,880 |
| 12..... | 6 or under | 2.84 | 47,460 | 4.4 | 208,824.0 | | |
| | 7 | 3.92 | 160 | 8.9 | 1,424.0 | | |
| | 8 | 4.11 | 1,248 | 11.4 | 14,227.2 | | |
| | 10 | 4.94 | 1,990 | 20.3 | 40,397.0 | | |
| | 12 | 5.92 | 542 | 34.3 | 18,590.6 | | |
| | 14 | 5.21 | 400 | 31.8 | 12,720.0 | | |
| | 15 | 5.46 | 500 | 36.8 | 18,400.0 | | |
| | 16 | 6.03 | 1,080 | 47.8 | 51,624.0 | | |
| | 18 | 7.29 | 270 | 78.3 | 21,141.0 | | |
| | 20 | 7.12 | 1,542 | 83.0 | 127,986.0 | | |
| | 22 | 5.37 | 808 | 53.4 | 43,147.2 | 558,481.0 | 9,720 |
| 14..... | 5 | 3.35 | 1,650 | 5.5 | 9,075.0 | 9,075.0 | 100 |
| 15..... | 6 or under | 3.54 | 47,731 | 6.2 | 295,932.2 | | |
| | 7 | 5.41 | 1,750 | 17.0 | 29,750.0 | | |
| | 8 | 4.93 | 1,150 | 16.0 | 18,400.0 | | |
| | 9 | 5.19 | 1,300 | 20.2 | 26,260.0 | | |
| | 10 | 4.74 | 400 | 18.7 | 7,480.0 | | |
| | 12 | 4.53 | 2,500 | 20.0 | 50,000.0 | | |
| | 14 | 5.00 | 1,110 | 29.7 | 32,967.0 | | |
| | 15 | 3.47 | 190 | 15.2 | 2,888.0 | | |
| | 18 | 5.50 | 35 | 44.6 | 1,551.0 | 465,228.2 | 5,420 |
| 17..... | 6 or under | 3.91 | 9,113 | 7.6 | 69,258.8 | | |
| | 7 | 4.05 | 700 | 9.5 | 6,650.0 | | |
| | 8 | 3.93 | 555 | 10.1 | 5,605.5 | | |
| | 10 | 4.49 | 1,100 | 16.5 | 19,585.5 | | |
| | 12 | 5.09 | 2,177 | 25.3 | 55,078.1 | | |
| | 16 | 7.28 | 1,880 | 68.5 | 128,780.0 | 284,957.9 | 2,360 |
| 18..... | 5 | 3.43 | 3,300 | 5.8 | 19,140.0 | 19,140.0 | 230 |
| Totals—average digging ..... | | | | | | 3,388,740.6 | 56,280 |
| Work units per man hour—average digging..... | | | | | | 60.2 | |
| Or practically ..... | | | | | | 60.0 | |

## TABLE XVIII

WORK UNITS, MAN HOURS, SIZE OF TILE, AND AVERAGE CUT FOR EACH PROJECT AND FOR ALL PROJECTS IN HARD DIGGING

| Farm project No. | Tile | | | Work units | | | Total man hours labor |
|---|---|---|---|---|---|---|---|
| | Inner diameter, inches | Average cut, feet | Total linear feet | Per linear foot | Total per item | Grand total per project | |
| 7..... | 6 or under | 3.19 | 5,633 | 5.0 | 28,165.0 | | |
| | 8 | 4.15 | 2,365 | 11.5 | 27,197.5 | | |
| | 10 | 4.10 | 1,270 | 13.5 | 17,145.0 | | |
| | 12 | 3.00 | 400 | 9.0 | 3,600.0 | 76,107.5 | 1,555 |
| 10..... | 6 or under | 3.64 | 8,904 | 6.3 | 56,095.2 | | |
| | 8 | 4.52 | 1,200 | 13.8 | 16,560.0 | | |
| | 10 | 4.79 | 1,214 | 19.4 | 23,351.6 | | |
| | 12 | 4.76 | 1,160 | 22.0 | 25,520.0 | 121,526.8 | 3,072 |
| Totals—hard digging ..... | | | | | | 197,634.3 | 4,627 |
| Work units per man hour—hard digging..... | | | | | | 43.0 | |

## TABLE XIX

SHOWING FACTORS ENTERING INTO COMPUTATION OF WORK UNITS PER LINEAR FOOT OF TRENCH
Kind of Tile—Clay or Concrete; Size of Tile—10-inch

| D | T | d | Y | $Y_1$ | A | y | g | G | g+G | A(g+G) | a | s | as | asD | Work units per lin. ft. A(g+G) + asD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3..... | 1.44 | 1.15 | 2.425 | 0.575 | 3.66 | 1.26 | 0.44 | 1.35 | 1.79 | 6.55 | 0.24 | 1⅛ | 0.27 | 0.81 | 7.36 |
| 4..... | 1.56 | | 3.425 | | 5.16 | 1.55 | 0.53 | 1.77 | 2.30 | 11.87 | | | | 1.08 | 12.95 |
| 5..... | 1.68 | | 4.425 | | 6.78 | 1.82 | 0.62 | 2.19 | 2.81 | 19.05 | | | | 1.35 | 20.40 |
| 6..... | 1.80 | | 5.425 | | 8.52 | 2.07 | 0.68 | 2.59 | 3.27 | 27.86 | | | | 1.62 | 29.48 |
| 7..... | 1.92 | | 6.425 | | 10.38 | 2.32 | 0.76 | 2.98 | 3.74 | 38.82 | | | | 1.89 | 40.71 |
| 8..... | 2.04 | | 7.425 | | 12.36 | 2.56 | 0.84 | 3.36 | 4.20 | 51.91 | | | | 2.16 | 54.07 |
| 9..... | 2.16 | | 8.425 | | 14.46 | 2.79 | 0.90 | 3.74 | 4.64 | 67.09 | | | | 2.43 | 69.52 |
| 10..... | 2.28 | | 9.425 | | 16.68 | 3.02 | 0.97 | 4.10 | 5.07 | 84.56 | | | | 2.70 | 87.26 |
| 11..... | 2.40 | | 10.425 | | 19.02 | 3.24 | 1.03 | 4.45 | 5.48 | 104.23 | | | | 2.97 | 107.20 |
| 12..... | 2.52 | 1.15 | 11.425 | 0.575 | 21.48 | 3.47 | 1.11 | 4.82 | 5.93 | 127.38 | 0.24 | 1⅛ | 0.27 | 3.24 | 130.62 |

**Note:** Values in columns d, $Y_1$, a, s, as, are the same for each item as those shown in the first and last items.

TABLE XX

WORK UNITS PER LINEAR FOOT OF TRENCH FOR SIZES OF TILE 4- TO 24-INCH AND FOR DEPTHS OF TRENCH FROM 3 TO 12 FEET

| Diam. of tile | Work units per linear foot for depths of trench shown on next line | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3-ft. | 4-ft. | 5-ft. | 6-ft. | 7-ft. | 8-ft. | 9-ft. | 10-ft. | 11-ft. | 12-ft. |
| Inches | | | | | | | | | | |
| 4, 5, and 6..... | 4.39 | 7.93 | 12.72 | 18.81 | 26.37 | 35.60 | 46.43 | 59.42 | 73.80 | 90.57 |
| 8..... | 5.74 | 10.47 | 16.33 | 24.59 | 33.52 | 44.45 | 57.74 | 72.85 | 90.28 | 109.90 |
| 10..... | 7.36 | 12.95 | 20.40 | 29.48 | 40.71 | 54.07 | 69.52 | 87.26 | 107.20 | 130.62 |
| 12..... | 9.01 | 15.67 | 24.16 | 35.20 | 48.39 | 63.68 | 81.59 | 101.90 | 125.24 | 150.90 |
| 14..... | 10.65 | 18.58 | 28.59 | 41.00 | 56.08 | 73.64 | 93.91 | 117.00 | 142.51 | 172.21 |
| 16..... | 12.37 | 21.31 | 32.77 | 46.91 | 63.79 | 83.51 | 106.21 | 132.43 | 160.87 | 183.29 |
| 18..... | 14.03 | 24.19 | 37.09 | 52.97 | 71.94 | 93.31 | 118.88 | 147.64 | 179.31 | 214.64 |
| 20..... | 15.93 | 27.19 | 41.57 | 59.18 | 79.99 | 104.20 | 132.15 | 163.21 | 197.93 | 237.27 |
| 22..... | 17.75 | 30.37 | 46.27 | 65.57 | 88.27 | 115.05 | 145.16 | 179.06 | 217.42 | 259.18 |
| 24..... | 19.74 | 33.41 | 50.82 | 72.07 | 97.06 | 125.59 | 158.55 | 195.33 | 236.24 | 281.73 |

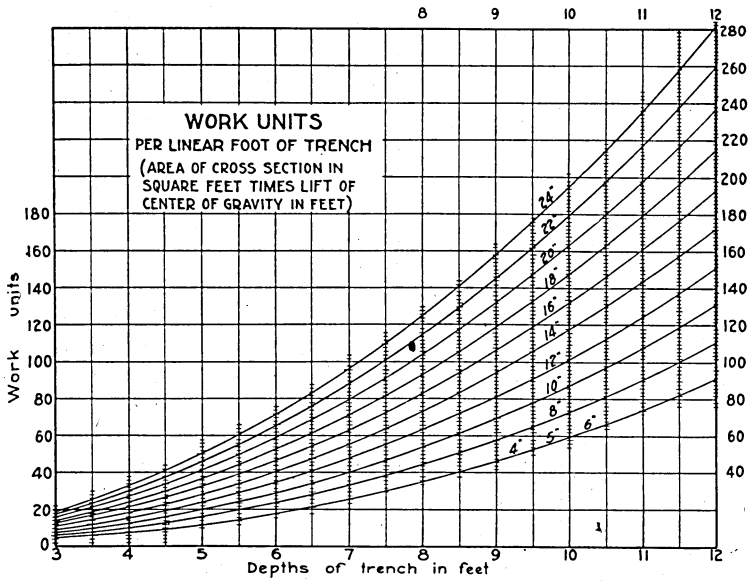



Fig. 20. Curves Showing Data in Table XX

TABLE XXI

HOURS REQUIRED TO DIG 100 LINEAR FEET OF TRENCH FOR SIZES OF TILE FROM 4-INCH TO 24-INCH, AND FOR DEPTHS OF TRENCH FROM 3 FEET TO 12 FEET

(Easy Digging—70 Work Units per Hour. Average of 2 Projects Only)

| Diam. of tile | Hours per linear foot for depths of trench shown on next line | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3-ft. | 4-ft. | 5-ft. | 6-ft. | 7-ft. | 8-ft. | 9-ft. | 10-ft. | 11-ft. | 12-ft. |
| Inches | | | | | | | | | | |
| 4, 5, and 6..... | 6.27 | 11.33 | 18.17 | 26.87 | 37.67 | 50.86 | 66.33 | 84.89 | 105.43 | 129.39 |
| 8..... | 8.20 | 14.96 | 23.33 | 35.13 | 47.89 | 63.50 | 82.19 | 104.07 | 128.97 | 157.00 |
| 10..... | 10.51 | 18.50 | 29.14 | 42.11 | 58.16 | 77.24 | 99.31 | 124.66 | 153.14 | 187.70 |
| 12..... | 12.87 | 22.39 | 34.51 | 50.29 | 69.13 | 90.97 | 116.56 | 145.57 | 178.91 | 215.57 |
| 14..... | 15.21 | 26.54 | 40.84 | 58.57 | 80.11 | 105.20 | 134.16 | 167.14 | 203.59 | 246.01 |
| 16..... | 17.67 | 30.44 | 46.81 | 67.01 | 91.13 | 119.30 | 151.73 | 189.19 | 229.81 | 276.13 |
| 18..... | 20.04 | 34.56 | 52.99 | 75.67 | 102.77 | 133.30 | 169.83 | 210.91 | 256.16 | 306.63 |
| 20..... | 22.76 | 38.84 | 59.39 | 84.54 | 114.27 | 148.86 | 188.79 | 233.16 | 282.76 | 338.96 |
| 22..... | 25.36 | 43.39 | 66.10 | 93.67 | 126.10 | 164.36 | 207.37 | 255.80 | 310.60 | 370.26 |
| 24..... | 28.20 | 47.73 | 72.60 | 102.96 | 138.66 | 179.41 | 226.50 | 279.04 | 337.49 | 402.47 |

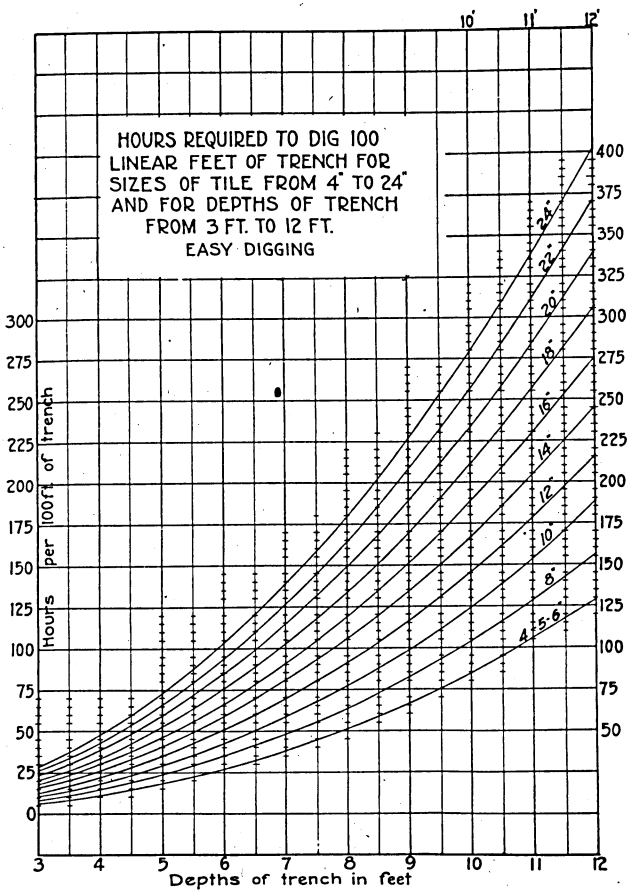



Fig. 21. Curves Showing Data in Table XXI

TABLE XXII

HOURS REQUIRED TO DIG 100 LINEAR FEET OF TRENCH FOR SIZES OF TILE FROM 4-INCH TO 24-INCH, AND FOR DEPTHS OF TRENCH FROM 3 FEET TO 12 FEET
(Average Digging—60 Work Units per Hour. Average of 14 Projects)

| Diam. of tile | Hours per 100 linear feet for depths of trench shown on next line | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3-ft. | 4-ft. | 5-ft. | 6-ft. | 7-ft. | 8-ft. | 9-ft. | 10-ft. | 11-ft. | 12-ft. |
| Inches | | | | | | | | | | |
| 4, 5, and 6..... | 7.32 | 13.22 | 21.20 | 31.35 | 43.95 | 59.33 | 77.38 | 99.03 | 123.00 | 150.95 |
| 8..... | 9.57 | 17.45 | 27.22 | 40.98 | 55.87 | 74.08 | 96.23 | 121.42 | 150.47 | 183.17 |
| 10..... | 12.27 | 21.58 | 34.00 | 49.13 | 67.85 | 90.12 | 115.87 | 145.43 | 178.67 | 217.70 |
| 12..... | 15.02 | 26.12 | 40.27 | 58.67 | 80.65 | 106.13 | 135.97 | 169.67 | 208.73 | 251.50 |
| 14..... | 17.75 | 30.97 | 47.65 | 68.33 | 93.47 | 122.73 | 156.52 | 195.00 | 237.09 | 287.04 |
| 16..... | 20.62 | 35.52 | 54.62 | 78.18 | 106.32 | 139.18 | 177.02 | 220.72 | 268.12 | 322.15 |
| 18..... | 23.38 | 40.32 | 61.82 | 88.28 | 119.90 | 155.52 | 198.13 | 246.07 | 298.85 | 357.73 |
| 20..... | 26.55 | 45.32 | 69.28 | 98.63 | 133.32 | 173.67 | 220.25 | 272.02 | 329.88 | 395.45 |
| 22..... | 29.58 | 50.62 | 77.12 | 109.28 | 147.12 | 191.75 | 241.93 | 298.43 | 362.37 | 431.97 |
| 24..... | 32.90 | 55.68 | 84.70 | 120.12 | 161.77 | 209.32 | 264.25 | 325.50 | 393.73 | 469.55 |

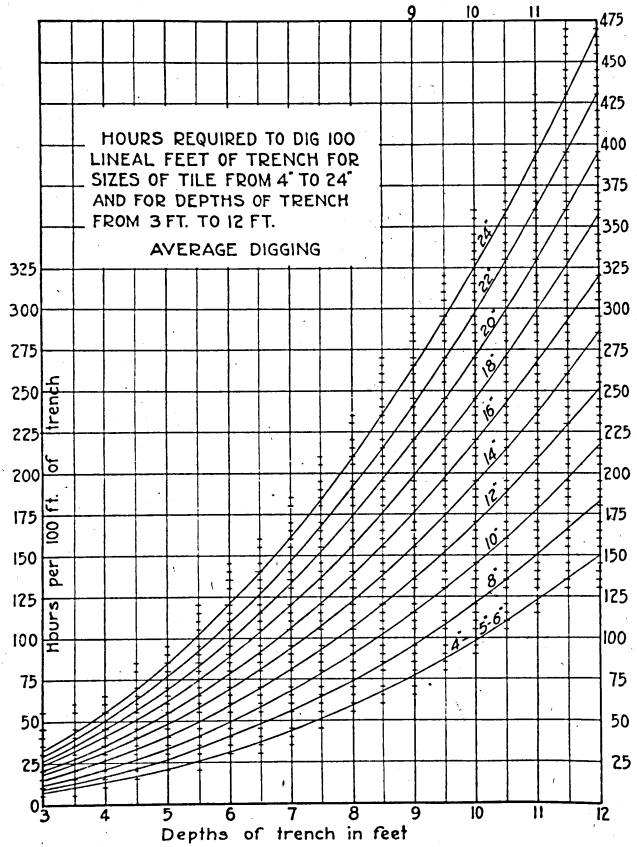



Fig. 22. Curves Showing Data in Table XXII

TABLE XXIII

HOURS REQUIRED TO DIG 100 LINEAR FEET OF TRENCH FOR SIZES OF TILE FROM 4-INCH TO 24-INCH, AND FOR DEPTHS OF TRENCH FROM 3 FEET TO 12 FEET

(Hard Digging—43 Work Units per Hour. Average of 2 Projects Only)

| Diam. of tile | Hours per 100 linear feet for depths of trench shown on next line | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3-ft. | 4-ft. | 5-ft. | 6-ft. | 7-ft. | 8-ft. | 9-ft. | 10-ft. | 11-ft. | 12-ft. |
| Inches | | | | | | | | | | |
| 4, 5, and 6..... | 10.21 | 18.44 | 29.58 | 43.74 | 61.33 | 82.79 | 107.97 | 138.19 | 171.63 | 210.63 |
| 8..... | 13.35 | 24.35 | 37.98 | 57.19 | 77.95 | 103.37 | 134.28 | 169.42 | 209.95 | 255.58 |
| 10..... | 17.12 | 30.12 | 47.44 | 68.56 | 94.67 | 125.74 | 161.67 | 202.93 | 249.30 | 303.76 |
| 12..... | 20.95 | 36.44 | 56.19 | 81.86 | 112.53 | 148.09 | 189.74 | 236.98 | 291.26 | 350.93 |
| 14..... | 24.77 | 43.21 | 66.49 | 95.35 | 130.42 | 171.26 | 218.40 | 272.09 | 331.42 | 400.49 |
| 16..... | 28.77 | 49.56 | 76.21 | 109.09 | 148.35 | 194.21 | 247.00 | 307.97 | 374.12 | 449.51 |
| 18..... | 32.63 | 56.26 | 86.26 | 123.19 | 167.30 | 217.00 | 276.46 | 343.35 | 417.00 | 499.16 |
| 20..... | 37.05 | 63.23 | 96.67 | 137.63 | 186.02 | 242.33 | 307.33 | 379.56 | 460.30 | 551.79 |
| 22..... | 41.28 | 70.63 | 107.60 | 152.49 | 205.28 | 267.56 | 337.58 | 416.42 | 505.63 | 600.42 |
| 24..... | 45.91 | 77.70 | 118.86 | 167.60 | 225.72 | 292.07 | 368.72 | 454.26 | 549.40 | 655.19 |

Note.—For corresponding curves see Fig. 23, page 69.

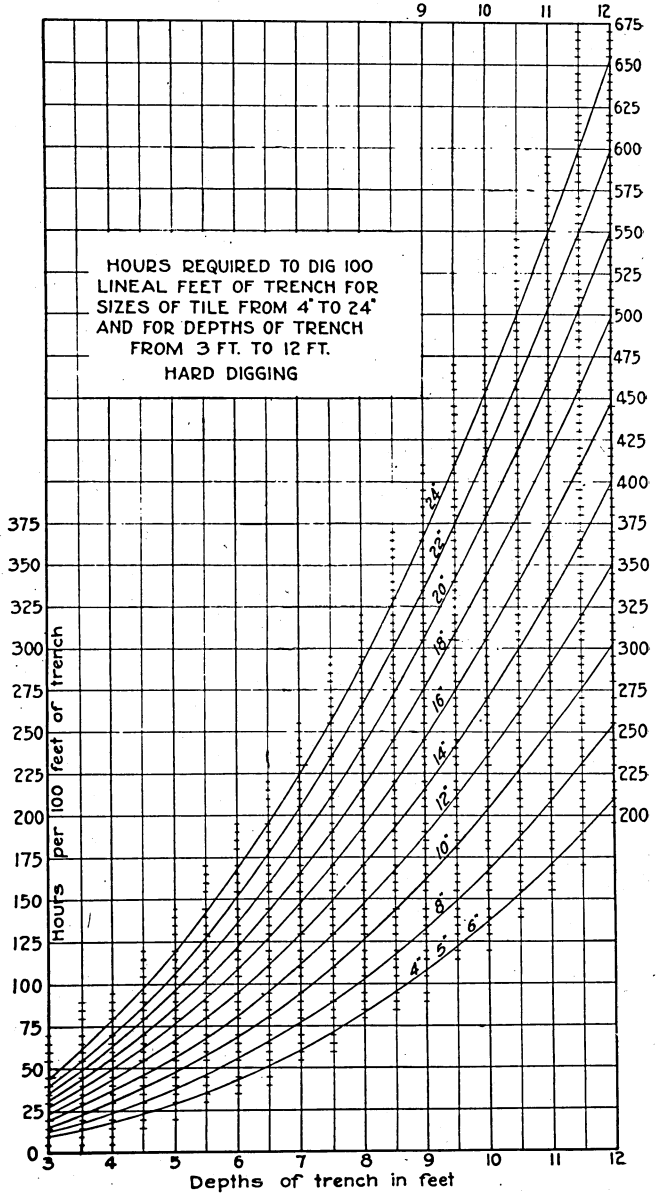



Fig. 23. Curves Showing Data in Table XXIII

TABLE XXIV

COST IN MONEY AND IN TIME OF REFILLING TRENCHES PER HOUR UNIT, PER ACRE, AND PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Cost in dollars | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Per hour unit | Per acre | | | Per | | |
| | | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | | |
| 1 | $ 39.36 | $0.43 | $0.54 | $2.62 | $ 3.94 | $ 4.47 | $1.05 | $15.81 |
| 3 | 65.00 | 0.44 | 0.86 | 4.64 | 4.64 | 10.34 | 2.11 | 31.71 |
| 7 | 47.36 | 0.45 | 0.40 | 2.37 | 5.92 | 4.90 | 0.76 | 11.34 |
| 8 | 132.60 | 0.60 | 0.56 | 2.37 | 2.37 | 4.83 | 0.69 | 10.37 |
| 10 | 207.61 | 0.54 | 1.30 | 5.19 | 15.97 | 16.64 | 2.54 | 37.81 |
| 14 | 12.00 | 0.52 | 3.43 | 6.00 | 12.00 | 7.27 | 1.62 | 24.24 |
| 15 | 289.80 | 0.80 | 0.58 | 1.70 | 2.42 | 5.16 | 0.94 | 14.12 |
| 17 | 34.08 | 0.36 | 0.25 | 0.97 | 0.97 | 2.20 | 0.18 | 2.66 |
| Totals | $ 827.81 | .... | .... | .... | .... | .... | .... | ..... |
| Averages | ..... | $0.58 | $0.63 | $2.35 | $3.22 | $6.00 | $0.91 | $13.61 |
| **Flat Land** | | | | | | | | |
| 2 | $ 67.50 | $0.35 | $0.42 | $0.42 | $ 0.84 | $ 1.89 | $0.27 | $ 4.03 |
| 4 | 36.00 | 0.54 | 0.90 | 1.03 | 7.20 | 8.45 | 2.08 | 31.03 |
| 5 | 42.08 | 0.49 | 0.23 | 0.35 | 0.42 | 1.64 | 0.19 | 2.86 |
| 6 | 57.00 | 0.45 | 0.48 | 0.48 | 0.60 | 2.88 | 0.67 | 10.02 |
| 9 | 403.60 | 1.16 | 4.25 | 4.25 | 12.61 | 8.70 | 1.92 | 28.87 |
| 11 | 250.00 | 0.81 | 0.83 | 1.60 | 3.29 | 4.52 | 0.56 | 8.33 |
| 12 | 340.00 | 1.07 | 1.33 | 3.40 | 4.53 | 6.07 | 0.63 | 9.39 |
| 18 | 3.90 | 0.07 | 0.56 | 0.78 | 1.56 | 1.18 | 0.25 | 3.73 |
| Totals | $1,200.08 | .... | .... | .... | .... | .... | .... | ..... |
| Averages | ..... | $0.80 | $1.03 | $1.52 | $2.58 | $4.87 | $0.67 | $10.04 |
| **Peat Land** | | | | | | | | |
| 13 | $ 196.04 | $2.33 | $4.90 | $ 7.00 | $ 7.00 | $13.73 | $2.69 | $40.34 |
| 16 | 50.00 | 1.92 | 2.50 | 3.33 | 3.33 | 11.99 | 2.66 | 39.87 |
| Totals | $ 246.04 | .... | .... | .... | .... | .... | .... | ..... |
| Averages | ..... | $2.24 | $4.10 | $5.72 | $5.72 | $13.34 | $2.68 | $40.27 |
| Grand totals | $2,273.93 | .... | .... | .... | .... | .... | .... | ..... |
| Grand average | ..... | $0.75 | $0.90 | $1.92 | $2.97 | $5.65 | $0.76 | $12.19 |

TABLE XXIV—*Continued*

COST IN MONEY AND IN TIME OF REFILLING TRENCHES PER HOUR UNIT, PER ACRE, AND PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Time in hour units* | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total hour units | Per acre | | | Per | | |
| | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | |
| 1 | 92 | 1.26 | 6.13 | 9.20 | 10.45 | 2.47 | 36.95 |
| 3 | 149 | 1.96 | 10.64 | 10.64 | 23.71 | 4.84 | 72.68 |
| 7 | 104 | 0.87 | 5.20 | 13.00 | 10.76 | 1.66 | 24.88 |
| 8 | 221 | 0.93 | 3.95 | 3.95 | 8.05 | 1.15 | 17.28 |
| 10 | 385 | 2.40 | 9.62 | 29.62 | 30.85 | 4.71 | 70.13 |
| 14 | 23 | 6.57 | 11.50 | 23.00 | 13.94 | 3.10 | 46.00 |
| 15 | 361 | 0.72 | 2.12 | 3.01 | 6.43 | 1.17 | 17.58 |
| 17 | 94 | 0.69 | 2.69 | 2.68 | 6.05 | 0.49 | 7.34 |
| Totals | 1,429 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 1.09 | 4.06 | 5.56 | 10.36 | 1.57 | 23.49 |
| **Flat Land** | | | | | | | |
| 2 | 194 | 1.21 | 1.21 | 2.42 | 5.44 | 0.77 | 11.59 |
| 4 | 67 | 1.68 | 1.91 | 1.34 | 15.73 | 3.87 | 57.76 |
| 5 | 85 | 0.46 | 0.71 | 0.85 | 3.31 | 0.38 | 5.77 |
| 6 | 127 | 1.06 | 1.06 | 1.34 | 6.42 | 1.49 | 22.32 |
| 9 | 349 | 3.67 | 3.67 | 10.91 | 7.52 | 1.66 | 24.96 |
| 11 | 307 | 1.02 | 1.97 | 4.04 | 5.56 | 0.68 | 10.23 |
| 12 | 319 | 1.25 | 3.19 | 4.25 | 5.69 | 0.59 | 8.81 |
| 18 | 53 | 7.57 | 10.60 | 21.20 | 16.06 | 3.38 | 50.48 |
| Totals | 1,501 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 1.29 | 1.90 | 3.22 | 6.09 | 0.84 | 12.56 |
| **Peat Land** | | | | | | | |
| 13 | 84 | 2.10 | 3.00 | 3.00 | 5.88 | 1.15 | 17.28 |
| 16 | 26 | 1.30 | 1.73 | 1.73 | 6.24 | 1.39 | 20.80 |
| Totals | 110 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 1.83 | 2.56 | 2.56 | 5.96 | 1.20 | 18.00 |
| Grand totals | 3,040 | .... | .... | .... | ..... | .... | ..... |
| Grand averages | .... | 1.20 | 2.56 | 3.97 | 7.55 | 1.02 | 16.30 |

* The hour unit here used is a composite unit of 1 team hour plus 1⅓ man hours.

## TABLE XXV

AREAS AND VOLUMES OF TRENCHES FOR SIZES OF TILE AND AVERAGE DEPTHS OF TRENCH THEREFOR

| Farm project No. | 4-, 5-, and 6-inch Tile | | | | 7-inch Tile | | | | 8-inch Tile | | | | Grand total volume, cubic feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average cut, feet | Trench | | | Average cut, feet | Trench | | | Average cut, feet | Trench | | | |
| | | Linear feet | Area of cross section, square feet | Volume, cubic feet | | Linear feet | Area of cross-section, square feet | Volume, cubic feet | | Linear feet | Area of cross-section, square feet | Volume, cubic feet | |
| 1 | 3.34 | 7,100 | 2.80 | 19,880 | 3.77 | 900 | 3.70 | 3,330 | 4 06 | 800 | 4.40 | 3,520 | |
| 2 | 2.80 | 30,700 | 2.45 | 75,215 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 3 | 4.03 | 4,110 | 3.55 | 14,591 | ... | .... | ... | ..... | 4.50 | 2,175 | 5.05 | 10,984 | |
| 4 | 3.31 | 3,635 | 2.80 | 10,178 | 5.05 | 450 | 5.30 | 2,385 | 5.05 | 175 | 5.80 | 1,015 | |
| 5 | 3.13 | 21,065 | 2.60 | 54,769 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 6 | 3.14 | 17,150 | 2.60 | 44,590 | ... | .... | ... | ..... | 2.70 | 1,355 | 2.70 | 3,659 | |
| 7 | 3.19 | 5,633 | 2 66 | 14.984 | ... | .... | ... | ..... | 4.15 | 2,365 | 4.55 | 10,761 | |
| 8 | 3.31 | 20,813 | 2.80 | 58,276 | 3.55 | 1,190 | 2.45 | 2,916 | 3.90 | 800 | 4.20 | 3,360 | |
| 9 | 3.29 | 42,657 | 2.80 | 119,440 | ... | .... | ... | ..... | 3.34 | 1,040 | 3.45 | 3,588 | |
| 10 | 3.64 | 8,904 | 3.10 | 27,602 | ... | .... | ... | ..... | 4.52 | 1,200 | 5.05 | 6,060 | |
| 11 | 3.53 | 43,105 | 3.00 | 129,315 | ... | .... | ... | ..... | 4.85 | 2,675 | 5.50 | 14,712 | |
| 12 | 2.84 | 47,460 | 2.45 | 116,277 | 3.92 | 160 | 3.90 | 624 | 4.11 | 1,248 | 4.50 | 5,616 | |
| 13 | 3.56 | 12,325 | 3.00 | 36,975 | 4.80 | 700 | 5.00 | 3,500 | 4.20 | 1,250 | 4.60 | 5,750 | |
| 14 | 3.35 | 1,650 | 2.80 | 4,620 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 15 | 3.54 | 47,731 | 3.00 | 143,193 | 5.41 | 1,750 | 5.80 | 10,150 | 4.93 | 1,150 | 5.65 | 6,498 | |
| 16 | 3.41 | 4,170 | 2.90 | 12,093 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 17 | 3.91 | 9,113 | 3.40 | 30,984 | 4.05 | 700 | 4.05 | 2,835 | 3.93 | 555 | 4.25 | 2,359 | |
| 18 | 3.43 | 3,300 | 2.90 | 9,570 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| Totals | ... | ..... | ... | 922,552 | ... | .... | ... | 25,740 | ... | ..... | ... | 77,882 | 1,026,174 |
| | 9-inch Tile | | | | 10-inch Tile | | | | 12-inch Tile | | | | |
| 6 | ... | ..... | ... | ..... | 3.22 | 1,275 | 4.00 | 5,100 | ... | ..... | ... | ..... | |
| 7 | ... | ..... | ... | ..... | 4.10 | 1,270 | 5.30 | 6,731 | 3.00 | 400 | 4.25 | 1,700 | |
| 8 | ... | ..... | ... | ..... | 4.20 | 300 | 5.50 | 1,650 | 4.03 | 2,000 | 6.05 | 12,100 | |
| 9 | ... | ..... | ... | ..... | 3.30 | 760 | 4.10 | 3,116 | 3.60 | 450 | 5.30 | 2,385 | |
| 10 | ... | ..... | ... | ..... | 4.79 | 1,214 | 6.25 | 7,587 | 4.76 | 1,160 | 7.40 | 8,584 | |
| 11 | ... | ..... | ... | ..... | 5.39 | 2,900 | 7.50 | 21,750 | 5 55 | 6,000 | 8.80 | 52,800 | |
| 12 | ... | ..... | ... | ..... | 4 94 | 1,990 | 6.70 | 13,333 | 5.92 | 542 | 9.60 | 5,203 | |
| 15 | 5.19 | 1,300 | 6.60 | 8,580 | 4.74 | 400 | 6.15 | 2,460 | 4.53 | 2,500 | 6.95 | 17,375 | |
| 17 | ... | ..... | ... | ..... | 4.49 | 1,100 | 5.95 | 6,545 | 5.09 | 2,177 | 8.00 | 17,416 | |
| Totals | ... | ..... | ... | 8,580 | ... | .... | ... | 68,272 | ... | ..... | ... | 117,563 | 194,415 |
| Grand totals carried forward | | | | | | | | | | | | | 1,220,589 |

TABLE XXV—*Continued*

AREAS AND VOLUMES OF TRENCHES FOR SIZES OF TILE AND AVERAGE DEPTHS OF TRENCH THEREFOR

| Farm project No. | 14-inch Tile | | | | 15-inch Tile | | | | 16-inch Tile | | | | Grand total volume, cubic feet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average cut, feet | Trench | | | Average cut, feet | Trench | | | Average cut, feet | Trench | | | |
| | | Linear feet | Area of cross section, square feet | Volume, cubic feet | | Linear feet | Area of cross-section, square feet | Volume, cubic feet | | Linear feet | Area of cross-section, square feet | Volume, cubic feet | |
| Grand totals brought forward | | | | | | | | | | | | | 1,220,589 |
| 2 | ... | ..... | ... | ..... | 6.50 | 1,000 | 12.80 | 12,800 | 6.50 | 1,500 | 13.48 | 20,220 | |
| 5 | ... | ..... | ... | ..... | ... | .... | ... | ..... | 5.20 | 2,100 | 10.32 | 21,672 | |
| 8 | 4.30 | 200 | 7.40 | 1,480 | ... | .... | ... | ..... | 5.00 | 1,500 | 9.85 | 14,775 | |
| 9 | 4.70 | 1,500 | 8.20 | 12,300 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 11 | 5.52 | 200 | 9.95 | 1,990 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 12 | 5.21 | 400 | 9.30 | 3,720 | 5.46 | 500 | 10.35 | 5,175 | 6.03 | 1,080 | 12.30 | 13,284 | |
| 15 | 5.00 | 1,110 | 8.80 | 9,768 | 3.47 | 155 | 6.10 | 946 | ... | ..... | ... | ..... | |
| 17 | ... | ..... | ... | ..... | ... | .... | ... | ..... | 7.28 | 1,880 | 15.48 | 29,102 | |
| Totals | ... | ..... | ... | 29,258 | ... | .... | ... | 18,921 | ... | ..... | ... | 99,053 | 147,232 |
| | 18-inch Tile | | | | 20-inch Tile | | | | 22-inch Tile | | | | |
| 2 | 6.50 | 2,465 | 14.85 | 36,605 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 5 | 5.50 | 2,500 | 12.15 | 30,375 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 8 | 3.20 | 640 | 6.45 | 4,128 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| 11 | 6.11 | 330 | 13.75 | 4,537 | ... | .... | ... | ..... | 4.34 | 40 | 10.90 | 436 | |
| 12 | 7.29 | 270 | 17.05 | 4,604 | 7.12 | 1,542 | 17.95 | 27,679 | 5.37 | 808 | 13.95 | 11,272 | |
| 15 | 5.50 | 35 | 12.15 | 425 | ... | .... | ... | ..... | ... | ..... | ... | ..... | |
| Totals | ... | ..... | ... | 80,674 | ... | .... | ... | 27,679 | ... | ..... | ... | 11,708 | 120,061 |
| Grand totals | ... | ..... | ... | ..... | ... | .... | ... | ..... | ... | ..... | ... | ..... | 1,487,882 |

From Table V the total standard hour units of 1 team hour + 1⅓ man hours is 3,040; hence average cubic feet moved per hour unit equals $\frac{1,487,882}{3,040} = 489.4$ or practically 490.

TABLE XXVI

HOUR UNITS OF ONE TEAM HOUR PLUS ONE AND ONE-THIRD MAN HOURS REQUIRED TO FILL 100 LINEAR FEET OF TRENCH FOR SIZES OF TILE FROM 4-INCH TO 24-INCH AND FOR DEPTHS OF TRENCH FROM 3 FEET TO 12 FEET

| Diam. of tile | Hours per 100 linear feet for depths of trench shown on next line | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3-ft. | 4-ft. | 5-ft. | 6-ft. | 7-ft. | 8-ft. | 9-ft. | 10-ft. | 11-ft. | 12-ft. |
| Inches | | | | | | | | | | |
| 4, 5, and 6..... | 0.50 | 0.72 | 0.96 | 1.23 | 1.52 | 1.83 | 2.18 | 2.54 | 2.93 | 3.34 |
| 8..... | 0.62 | 0.88 | 1.17 | 1.50 | 1.82 | 2.18 | 2.56 | 2.97 | 3.40 | 3.86 |
| 10..... | 0.75 | 1.05 | 1.38 | 1.74 | 2.11 | 2.52 | 2.95 | 3.40 | 3.88 | 4.38 |
| 12..... | 0.87 | 1.22 | 1.60 | 2.00 | 2.42 | 2.87 | 3.34 | 3.84 | 4.36 | 4.91 |
| 14..... | 0.99 | 1.38 | 1.80 | 2.24 | 2.71 | 3.20 | 3.72 | 4.26 | 4.83 | 5.42 |
| 16..... | 1.11 | 1.55 | 2.01 | 2.49 | 3.01 | 3.55 | 4.11 | 4.69 | 5.30 | 5.94 |
| 18..... | 1.22 | 1.70 | 2.21 | 2.75 | 3.31 | 3.88 | 4.49 | 5.12 | 5.77 | 6.45 |
| 20..... | 1.33 | 1.86 | 2.41 | 2.99 | 3.59 | 4.21 | 4.86 | 5.54 | 6.24 | 6.96 |
| 22..... | 1.45 | 2.02 | 2.62 | 3.24 | 3.88 | 4.55 | 5.25 | 5.96 | 6.70 | 7.47 |
| 24..... | 1.56 | 2.17 | 2.81 | 3.47 | 4.16 | 4.87 | 5.61 | 6.37 | 7.16 | 7.97 |

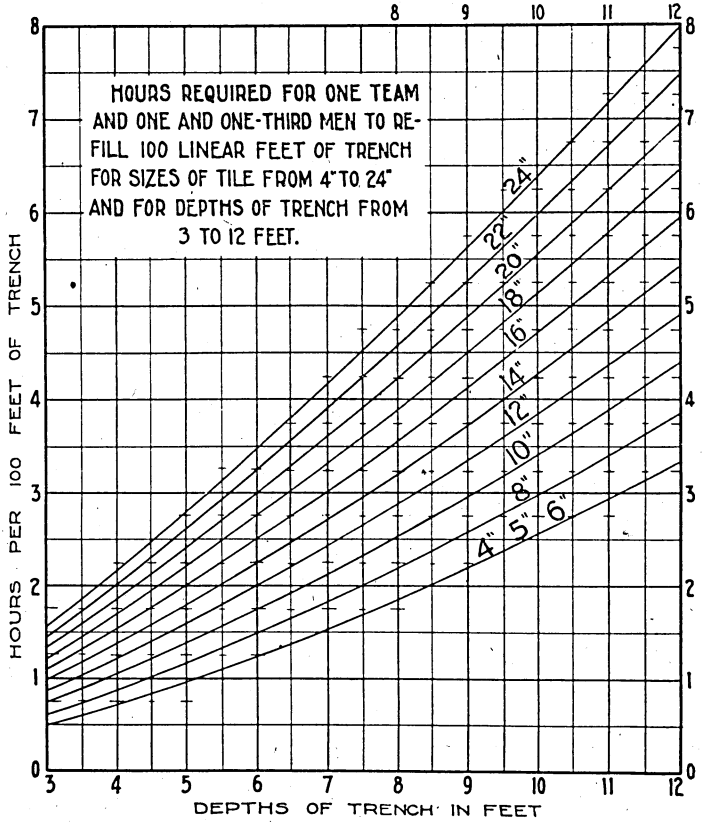



Fig. 24. Curves Showing Data in Table XXVI

TABLE XXVII

COST IN MONEY AND IN TIME, OF OUTLET PROTECTION PER MAN HOUR, PER ACRE; AND PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Cost in dollars | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Per hour | Per acre | | | Per | | |
| | | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | | |
| 1..... | | | | | | | | |
| 3..... | | | | | | | | |
| 7..... | | | | | | | | |
| 8..... | $ 21.50 | $0.43 | $0.09 | $0.38 | $ 0.38 | $ 0.78 | $0.11 | $1.68 |
| 10..... | 12.40 | .... | 0.08 | 0.31 | 0.95 | 0.99 | 0.15 | 2.26 |
| 14..... | 19.40 | 1.94 | 5.54 | 9.70 | 19.40 | 11.76 | 2.61 | 39.19 |
| 15..... | 72.50 | .... | 0.15 | 0.43 | 0.60 | 1.29 | 0.24 | 3.53 |
| 17..... | 37.08 | .... | 0.27 | 1.06 | 1.06 | 2.39 | 0.19 | 2.90 |
| Totals..... | $162.88 | .... | .... | .... | .... | .... | .... | ..... |
| Averages.... | ..... | $2.71 | $0.12 | $0.46 | $0.63 | $1.18 | $0.18 | $2.68 |
| **Flat Land** | | | | | | | | |
| 2..... | $25.00 | $0.31 | $0.16 | $0.16 | $0.31 | $0.70 | $0.10 | $1.49 |
| 4..... | 13.06 | 1.30 | 0.33 | 0.37 | 2.61 | 3.07 | 0.75 | 11.26 |
| 5..... | 27.75 | 0.40 | 0.15 | 0.23 | 0.28 | 1.08 | 0.13 | 1.88 |
| 6..... | 26.00 | 0.58 | 0.22 | 0.22 | 0.27 | 1.31 | 0.31 | 4.57 |
| 9..... | 62.03 | 3.10 | 0.65 | 0.65 | 1.94 | 1.34 | 0.30 | 4.44 |
| 11..... | 62.50 | .... | 0.21 | 0.40 | 0.82 | 1.13 | 0.14 | 2.08 |
| 12..... | 26.00 | 0.58 | 0.10 | 0.26 | 0.35 | 0.46 | 0.05 | 0.72 |
| 18..... | | | | | | | | |
| Totals..... | $242.34 | .... | .... | .... | .... | .... | .... | ..... |
| Averages.... | ..... | $0.90 | $0.21 | $0.31 | $0.52 | $0.98 | $0.14 | $2.03 |
| **Peat Land** | | | | | | | | |
| 13..... | $37.91 | $3.79 | $0.95 | $1.35 | $1.35 | $2.66 | $0.52 | $7.80 |
| 16..... | | | | | | | | |
| Totals..... | $37.91 | .... | .... | .... | .... | .... | .... | ..... |
| Averages.... | ..... | $3.79 | $0.63 | $0.88 | $0.88 | $2.06 | $0.41 | $6.20 |
| Grand totals.. | $443.13 | .... | .... | .... | .... | .... | .... | ..... |
| Grand averages ..... | ..... | $1.30 | $0.18 | $0.37 | $0.58 | $1.10 | $0.15 | $2.38 |

TABLE XXVII—*Continued*

COST IN MONEY AND IN TIME, OF OUTLET PROTECTION PER MAN HOUR, PER ACRE; AND PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Time in hours | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total hours | Per acre | | | Per | | |
| | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | |
| 1 | | | | | | | |
| 3 | | | | | | | |
| 7 | | | | | | | |
| 8 | 50 | 0.21 | 0.89 | 0.89 | 1.82 | 0.26 | 3.91 |
| 10 | | | | | | | |
| 14 | 10 | 2.86 | 5.00 | 10.00 | 6.06 | 1.35 | 20.00 |
| 15 | | | | | | | |
| 17 | | | | | | | |
| Totals | 60 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 0.05 | 0.17 | 0.23 | 0.43 | 0.07 | 1.00 |
| **Flat Land** | | | | | | | |
| 2 | 80 | 0.50 | 0.50 | 1.00 | 2.24 | 0.32 | 4.78 |
| 4 | 10 | 0.25 | 0.29 | 2.00 | 2.35 | 0.58 | 8.62 |
| 5 | 70 | 0.38 | 0.58 | 0.70 | 2.73 | 0.32 | 4.75 |
| 6 | 45 | 0.38 | 0.38 | 0.47 | 2.28 | 0.53 | 7.91 |
| 9 | 20 | 0.21 | 0.21 | 0.62 | 0.43 | 0.10 | 1.43 |
| 11 | | | | | | | |
| 12 | 45 | 0.18 | 0.45 | 0.60 | 0.80 | 0.08 | 1.24 |
| 18 | | | | | | | |
| Totals | 270 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 0.23 | 0.34 | 0.58 | 1.10 | 0.15 | 2.26 |
| **Peat Land** | | | | | | | |
| 13 | 10 | 0.25 | 0.36 | 0.36 | 0.70 | 0.14 | 2.06 |
| 16 | | | | | | | |
| Totals | 10 | .... | .... | .... | ..... | .... | ..... |
| Averages | .... | 0.16 | 0.23 | 0.23 | 0.54 | 0.11 | 1.64 |
| Grand totals | 340 | .... | .... | .... | ..... | .... | ..... |
| Grand averages | .... | 0.13 | 0.29 | 0.44 | 0.84 | 0.11 | 1.82 |

TABLE XXVIII

COST IN MONEY AND IN TIME, OF MISCELLANEOUS PER MAN HOUR, PER ACRE; AND PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Cost in dollars | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Per hour | Per acre | | | Per | | |
| | | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | | |
| 1..... | $17.54 | .... | $0.24 | $1.17 | $1.75 | $1.99 | $0.47 | $7.04 |
| 3..... | | | | | | | | |
| 7..... | 37.50 | .... | 0.31 | 1.88 | 4.69 | 3.88 | 0.60 | 8.98 |
| 8..... | 61.37 | $0.31 | 0.26 | 1.10 | 1.10 | 2.24 | 0.32 | 4.80 |
| 10..... | | | | | | | | |
| 14..... | | | | | | | | |
| 15..... | | | | | | | | |
| 17..... | | | | | | | | |
| Totals..... | $116.41 | .... | .... | .... | .... | .... | .... | ..... |
| Averages.... | ..... | $0.58 | $0.09 | $0.33 | $0.45 | $0.84 | $0.13 | $1.91 |
| **Flat Land** | | | | | | | | |
| 2..... | | | | | | | | |
| 4..... | | | | | | | | |
| 5..... | | | | | | | | |
| 6..... | | | | | | | | |
| 9..... | | | | | | | | |
| 11..... | | | | | | | | |
| 12..... | | | | | | | | |
| 18..... | | | | | | | | |
| Totals..... | | | | | | | | |
| Averages.... | | | | | | | | |
| **Peat Land** | | | | | | | | |
| 13..... | $348.00 | $1.29 | $8.70 | $15.13 | $15.13 | $29.24 | $6.13 | $91.88 |
| 16..... | 201.35 | 2.40 | 10.07 | 13.42 | 13.42 | 48.29 | 10.73 | 160.95 |
| Totals..... | $549.35 | .... | .... | .... | .... | .... | .... | ..... |
| Averages.... | ..... | $1.55 | $9.16 | $12.78 | $12.78 | $29.78 | $5.99 | $89.91 |
| Grand totals.. | $665.76 | .... | .... | .... | .... | .... | .... | ..... |
| Grand averages ..... | ..... | $1.20 | $0.26 | $0.56 | $0.87 | $1.65 | $0.22 | $3.57 |

TABLE XXVIII—*Continued*

COST IN MONEY AND IN TIME, OF MISCELLANEOUS PER MAN HOUR, PER ACRE; AND PER 1000 LINEAR FEET, PER TON, AND PER CARLOAD OF TILE

| Farm project No. | Time in hours | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total hours | Per acre | | | Per | | |
| | | Of watershed on farm | Drained | Reclaimed | 1000 lin. ft. of tile | Ton of tile | Carload of tile |
| **Rolling Land** | | | | | | | |
| 1..... | | | | | | | |
| 3..... | | | | | | | |
| 7..... | | | | | | | |
| 8..... | 200 | 0.84 | 3.57 | 3.57 | 7.29 | 1.04 | 15.63 |
| 10..... | | | | | | | |
| 14..... | | | | | | | |
| 15..... | | | | | | | |
| 17..... | | | | | | | |
| Totals..... | 200 | .... | .... | .... | ..... | .... | ..... |
| Averages..... | .... | 0.15 | 0.57 | 0.78 | 1.45 | 0.22 | 3.29 |
| **Flat Land** | | | | | | | |
| 2..... | | | | | | | |
| 4..... | | | | | | | |
| 5..... | | | | | | | |
| 6..... | | | | | | | |
| 9..... | | | | | | | |
| 11..... | | | | | | | |
| 12..... | | | | | | | |
| 18..... | | | | | | | |
| Totals..... | | | | | | | |
| Averages..... | | | | | | | |
| **Peat Land** | | | | | | | |
| 13..... | 270 | 6.75 | 9.64 | 9.64 | 18.91 | 3.70 | 55.55 |
| 16..... | 84 | 4.20 | 5.60 | 5.60 | 20.14 | 4.47 | 67.20 |
| Totals..... | 354 | .... | .... | .... | ..... | .... | ..... |
| Averages..... | .... | 5.90 | 8.23 | 8.23 | 19.19 | 3.86 | 57.94 |
| Grand totals .... | 554 | .... | .... | .... | ..... | .... | ..... |
| Grand averages.. | .... | 0.22 | 0.47 | 0.72 | 1.38 | 0.19 | 2.97 |

TABLE XXIX

AVERAGE CUTS FROM HUB FOR GIVEN SIZES OF TILE

| Farm project No. | Average cuts for sizes of tile given on next line | | | | | | | | | | | | Average cut for all sizes over 6-in. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4-, 5-, and 6-inch | 7-inch | 8-inch | 9-inch | 10-inch | 12-inch | 14-inch | 15-inch | 16-inch | 18-inch | 20-inch | 22-inch | |
| **Rolling Land** | | | | | | | | | | | | | |
| 1 | 3.34 | 3.77 | 4.06 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3.91 |
| 3 | 3.05 | ... | 4.50 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.50 |
| 7 | 3.19 | ... | 4.15 | ... | 4.10 | 3.00 | ... | ... | ... | ... | ... | ... | 4.02 |
| 8 | 3.31 | 3.55 | 3.90 | ... | 4.20 | 4.03 | 4.30 | ... | 5.00 | 3.20 | ... | ... | 4.07 |
| 10 | 3.64 | ... | 4.52 | ... | 4.79 | 4.76 | ... | ... | ... | ... | ... | ... | 4.69 |
| 14 | 3.35 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 |
| 15 | 3.54 | 5.41 | 4.93 | 5.19 | 4.74 | 4.53 | 5.00 | 3.47 | ... | 5.50 | ... | ... | 4.92 |
| 17 | 3.91 | 4.05 | 3.93 | ... | 4.49 | 5.09 | ... | ... | 7.28 | ... | ... | ... | 5.42 |
| Averages | 3.48 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.63 |
| **Flat Land** | | | | | | | | | | | | | |
| 2 | 2.80 | ... | ... | ... | ... | ... | ... | 6.50 | 6.50 | 6.50 | ... | ... | 6.50 |
| 4 | 3.31 | 5.05 | 5.05 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 5.05 |
| 5 | 3.13 | ... | ... | ... | ... | ... | ... | ... | 5.20 | 5.50 | ... | ... | 5.36 |
| 6 | 3.14 | ... | 2.70 | ... | 3.22 | ... | ... | ... | ... | ... | ... | ... | 2.97 |
| 9 | 3.29 | ... | 3.34 | ... | 3.30 | 3.60 | 4.70 | ... | ... | ... | ... | ... | 3.89 |
| 11 | 3.53 | ... | 4.85 | ... | 5.39 | 5.55 | 5.52 | ... | ... | 6.11 | ... | 4.34 | 5.37 |
| 12 | 2.84 | 3.92 | 4.11 | ... | 4.94 | 5.92 | 5.21 | 5.46 | 6.03 | 7.29 | 7.12 | 5.37 | 5.55 |
| 18 | 3.43 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 |
| Averages | 3.14 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 5.24 |
| **Peat Land** | | | | | | | | | | | | | |
| 13 | 3.56 | 4.80 | 4.20 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.41 |
| 16 | 3.41 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.00 |
| Averages | 3.52 | 4.80 | 4.20 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.41 |
| Grand averages | 3.27 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4.94 |

TABLE XXX

AVERAGE SIZES OF TILE AND AVERAGE RATES OF GRADE

| Farm project No. | Average diameter of tile | | | | Average grades, per cent | | |
|---|---|---|---|---|---|---|---|
| | Over 6-inch | | All sizes | | | | |
| | Exact average | Nearest larger stock size | Exact average | Nearest larger stock size | For 6-inch tile or under | For tile over 6-inch | For all sizes of tile |
| **Rolling Land** | | | | | | | |
| 1..... | 7.47 | 8 | 5.19 | 6 | 1.92 | 2.30 | 1.99 |
| 3..... | 8.00 | 8 | 5.73 | 6 | 0.67 | 0.62 | 0.65 |
| 7..... | 9.03 | 9 | 6.69 | 7 | 0.91 | 0.83 | 0.88 |
| 8..... | 12.07 | 12 | 6.94 | 7 | 0.80 | 0.34 | 0.69 |
| 10..... | 9.98 | 10 | 6.50 | 7 | 1.11 | 1.73 | 1.29 |
| 14..... | 0.00 | .. | 5.00 | 5 | 1.60 | 0.00 | 1.60 |
| 15..... | 10.19 | 12 | 5.89 | 6 | 0.81 | 0.22 | 0.72 |
| 17..... | 11.94 | 12 | 8.09 | 9 | 0.34 | 0.18 | 0.28 |
| Averages.. | 10.46 | .. | 6.30 | 7 | 0.88 | 0.61 | 0.82 |
| **Flat Land** | | | | | | | |
| 2..... | 16.79 | 18 | 5.96 | 6 | 0.07 | 0.05 | 0.06 |
| 4..... | 7.28 | 8 | 5.05 | 6 | 0.76 | 0.08 | 0.66 |
| 5..... | 17.09 | 18 | 6.48 | 7 | 0.53 | 0.45 | 0.52 |
| 6..... | 8.97 | 9 | 5.05 | 6 | 0.10 | 0.10 | 0.10 |
| 9..... | 11.29 | 12 | 5.09 | 6 | 0.05 | 0.12 | 0.11 |
| 11..... | 10.87 | 12 | 6.42 | 7 | 0.21 | 0.13 | 0.19 |
| 12..... | 14.21 | 14 | 6.48 | 7 | 0.16 | 0.11 | 0.15 |
| 18..... | 0.00 | .. | 5.00 | 5 | 0.67 | 0.00 | 0.67 |
| Averages.. | 13.04 | 14 | 5.97 | 6 | 0.20 | 0.18 | 0.20 |
| **Peat Land** | | | | | | | |
| 13..... | 7.64 | 8 | 5.39 | 6 | 0.20 | 0.16 | 0.20 |
| 16..... | 0.00 | .. | 5.00 | 5 | 0.08 | 0.00 | 0.08 |
| Averages.. | 7.64 | 8 | 5.30 | 6 | 0.17 | 0.17 | 0.16 |
| Grand averages .. | 11.72 | 12 | 6.05 | 6 | 0.50 | 0.37 | 0.41 |

TABLE XXXI

APPROXIMATE WEIGHTS PER LINEAR FOOT OF STANDARD SIZES OF TILE

| Internal diameter | Weight per linear foot to nearest pound | | |
|---|---|---|---|
| | Clay or shale | Concrete | Average |
| Inches | Pounds | Pounds | Pounds |
| 4 | 6½ | 7 | 7 |
| 5 | 8 | 10 | 9 |
| 6 | 10 | 13 | 12 |
| 7 | 13 | 16 | 15 |
| 8 | 17 | 23 | 20 |
| 9 | 21 | 25 | 23 |
| 10 | 25 | 30 | 27 |
| 12 | 33 | 43 | 38 |
| 14 | 44 | 59 | 52 |
| 15 | 50 | 65 | 58 |
| 16 | 55 | 83 | 69 |
| 18 | 66 | 102 | 84 |
| 20 | 81 | 124 | 103 |
| 22 | 93 | 154 | 124 |
| 24 | 109 | 190 | 150 |